WASHINGTON STATE DEPARTMENT OF
Natural Resources

Restoration of Lost Corners by Proportionate Measurement

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2006 Land Survey Refresher Course
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The first GLO Restoration Circular, published in 1883, summarized Congressional legislation in five points. The wording has changed some in subsequent circulars, but the same five points appear in the most recent Restoration Circular in 1974.

First: That the boundaries of the public lands, when approved and accepted, are unchangeable.

Second: That the original township, section, and quarter-section corners must stand as the true corners which they were intended to represent whether in the place shown by the field notes or not.

Third: That quarter-quarter-section corners not established in the original survey shall be placed on the line connecting the section and quarter-section corners, and midway between them, except on the last half mile of section lines closing on the north and west boundaries of the township, or on the lines between fractional or irregular sections.

Fourth: That the center lines of a section are to be straight, running from the quarter section corner on one boundary to the corresponding corner on the opposite boundary.

Fifth: That in a fractional section where no opposite corresponding quarter section corner has been or can be established, the center line must be run from the proper quarter-section corner as nearly in a cardinal direction to the meander line, reservation, or other boundary of such fractional section, as due parallelism with the section boundaries will permit.

Added after the Fifth Point:

From the foregoing it will he evident that corners established in the public land surveys remain fixed in position and are unchangeable; and that lost or obliterated corners of those surveys must be restored to their original locations from the best available evidence of the official survey in which such corners were established.

Sequence of lines in a township subdivision

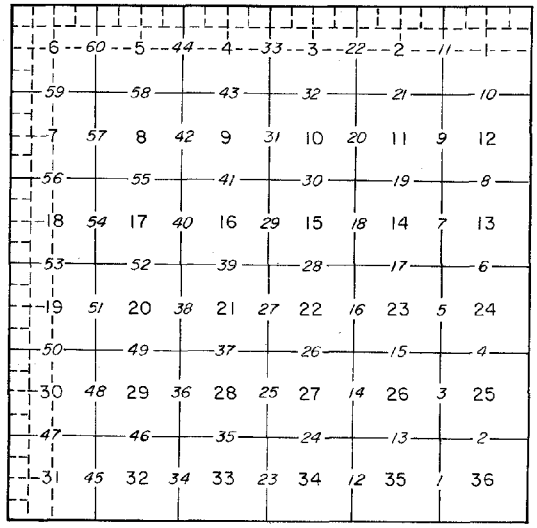
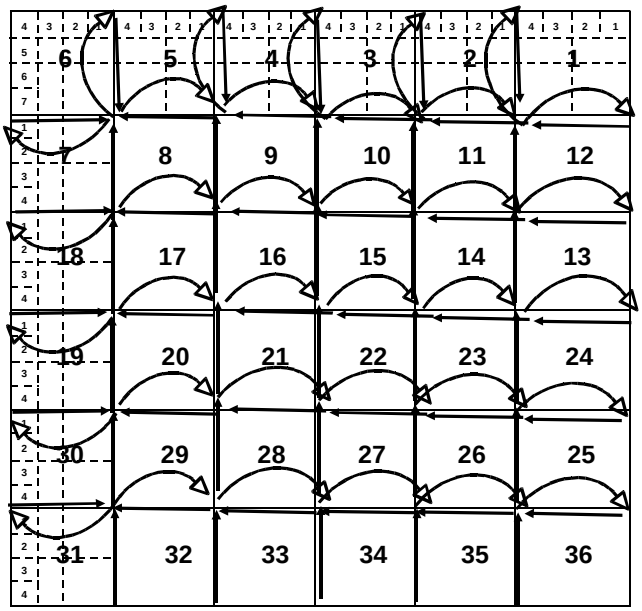


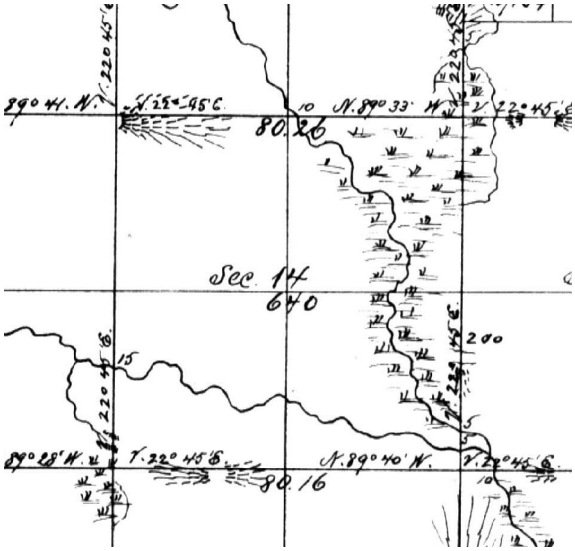
FIGURE 39.—Sequence of numbers on section lines shows normal order of subdivision.

Edward Tiffin's 1815 Instructions



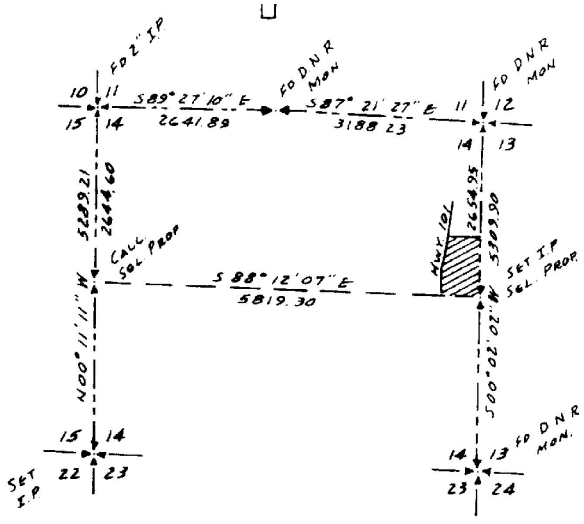
GLO Plat 1873 - Sec. 14, T28N, R2W

The Plat indicates a normal survey of the east west lines, run random and true, with the quarter corners set at midpoint.



Private Survey 1977 - Sec. 14, T28N, R2W

The retracement survey makes it obvious that the north quarter corner was stubbed in and set at 40 chains from the northwest section corner.

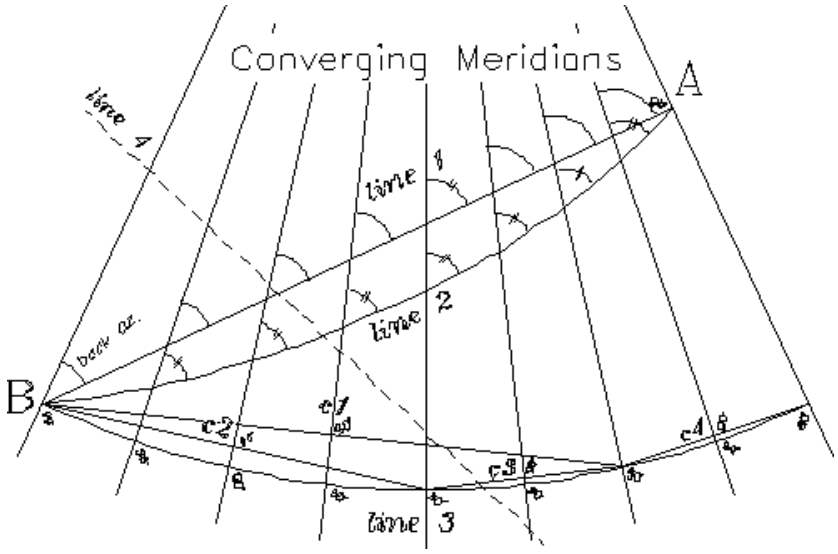


The Basis of Bearings for All Public Land Surveys

THE DIRECTION OF LINES

2-17. *The direction of each line of the public land surveys is determined with reference to the true meridian as defined by the axis of the earth's rotation. Bearings are stated in terms of angular measure referred to the true north or south.*

In Public Land Surveys lines which have the same bearing are not parallel and parallel lines have different bearings.



Principles of Law

- Federal Law, including the Manual of Surveying Instructions, governs boundary location of Public Lands.

- "Methods described in the 1973 Manual for the restoration of lost and obliterated corners follow leading judicial opinions and approved surveying practice."
  - (Manual 5-1)

UNITED STATES CODE
TITLE 43 - PUBLIC LANDS
CHAPTER 18 - SURVEY OF PUBLIC LANDS

§ 752 Boundaries and contents of public lands; how ascertained

First. All the corners marked in the surveys, returned by the Secretary of the Interior or such agency as he may designate, shall be established as the proper corners of sections, or subdivisions of sections, which they were intended to designate;

WAC 332-130-030 Land subdivision and corner restoration standards

(1) The reestablishment of lost GLO or BLM corners and the subdividing of sections shall be done according to applicable GLO or BLM plats and field notes and in compliance with the rules as set forth in the appropriate GLO or BLM Manual of Surveying Instructions, manual supplements and circulars. Federal or state court decisions that influence the interpretation of the rules should be considered. Methods used for such corner reestablishment or section subdivision shall be described on the survey map produced.

Proportioning is a Last Resort

BLM Manual 5-8.

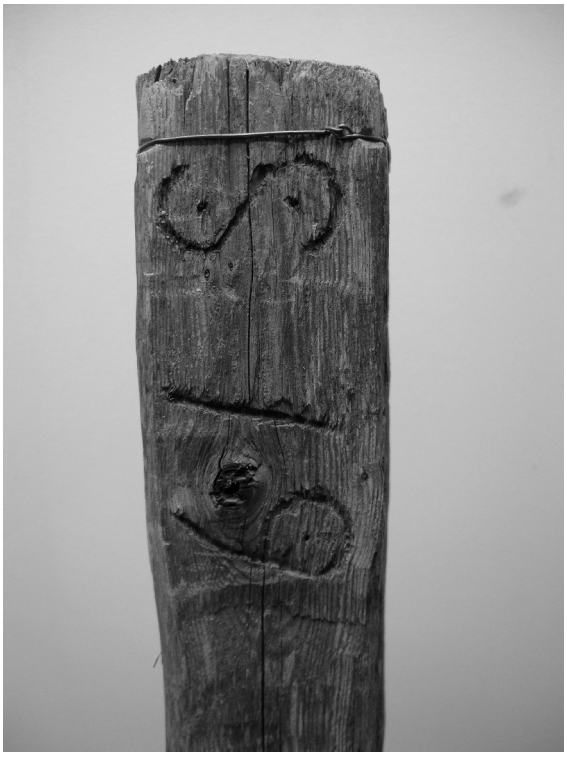
- *No decision should be made in regard to the restoration of a corner until every means has been exercised that might aid in identifying its true original position.*
- *The retracements will indicate the probable position and will show what discrepancies are to be expected.*
- *Any supplemental survey record or testimony should then be considered in the light of the facts thus developed.*

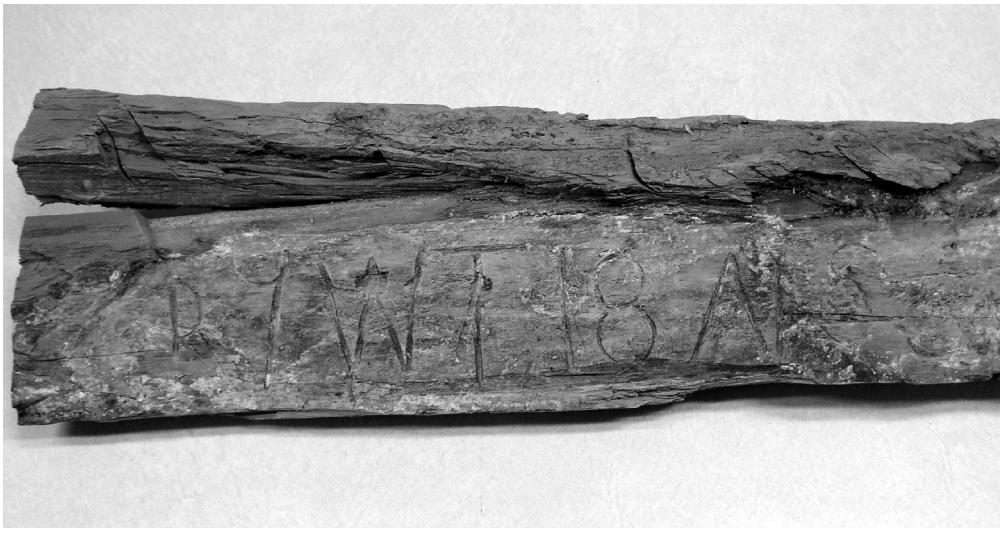
Corner vs. Monument

Existent, Obliterated, or Lost Corner?

Corner vs. Monument Manual 5-4

- terms NOT interchangeable
- A “corner” is a point determined by the surveying process.
- A “monument” is the object or the physical structure which marks the corner point.
  - “Accessories” (e.g., bearing trees, etc.) are a part of the corner’s monument





Existent Corner Manual 5-5

- *An existent corner is one whose position can be identified by verifying the evidence of the monument or its accessories, by reference to the description in the field notes, or can be located by an acceptable supplemental survey record, some physical evidence, or testimony.*
- *Even though its physical evidence may have entirely disappeared, a corner will not be regarded as lost if the position can be recovered through the testimony of witnesses.*

Obliterated Corner Manual 5-9

- *A corner at whose point there are no remaining traces of the monument or its accessories, but whose location has been perpetuated, or the point for which may be recovered… by testimony of landowners, competent surveyors, other qualified local authorities or witnesses, or by some acceptable record evidence.*
- *Collateral evidence must be supported through proper relation to known corners and agreement with the field notes… or unquestionable testimony.*

Lost Corner Manual 5-20

- *A lost corner is a point of a survey whose position cannot be determined, beyond reasonable doubt, either from traces of the original marks or from acceptable evidence or testimony that bears upon the original position, and whose location can be restored only by reference to one or more interdependent corners.*

Testimony
in the BLM Manual

5-10. A corner is not considered as lost if its position can be recovered satisfactorily by means of the testimony and acts of witnesses having positive knowledge of the precise location of the original monument.

Topography
in the BLM Manual

5-16. The proper use of topographic calls of the original field notes may assist in recovering the locus of the original survey. Such evidence may merely disprove other questionable features, or it may be a valuable guide to the immediate vicinity of a line or corner. At best, it may fix the position of a line or corner beyond reasonable doubt....

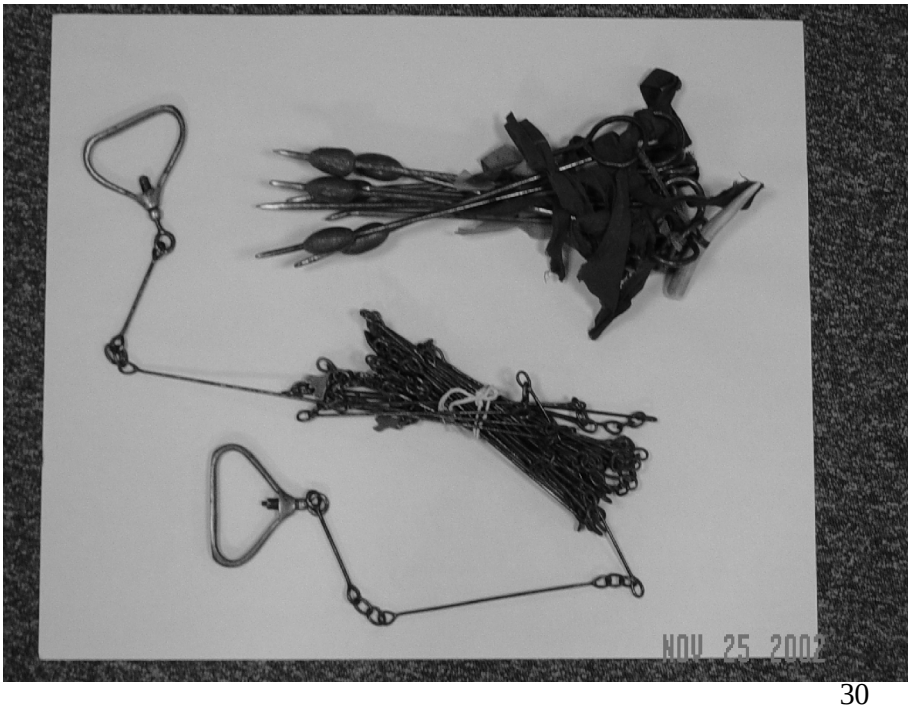
Topography
in the BLM Manual

5.16 (cont.) Misapplication usually may be avoided by applying the following tests:

(1) The determination should result in a definite locus within a small area.

(2) The evidence should not be susceptible of more than one reasonable interpretation.

(3) The corner locus should not be contradicted by evidence of a higher class or by other topographic notes.



1851 INSTRUCTIONS
TO THE SURVEYOR GENERAL OF OREGON

PROCESS OF CHAINING

Thus the chainmen alternately change places, each setting the pins that he has taken up, so that one is forward in all the odd, and the other in all the even tallies. Such procedure, it is believed, tends to ensure accuracy in measurement, facilitates the recollection of the distances to objects on the line, and renders a mis-tally almost impossible.

31

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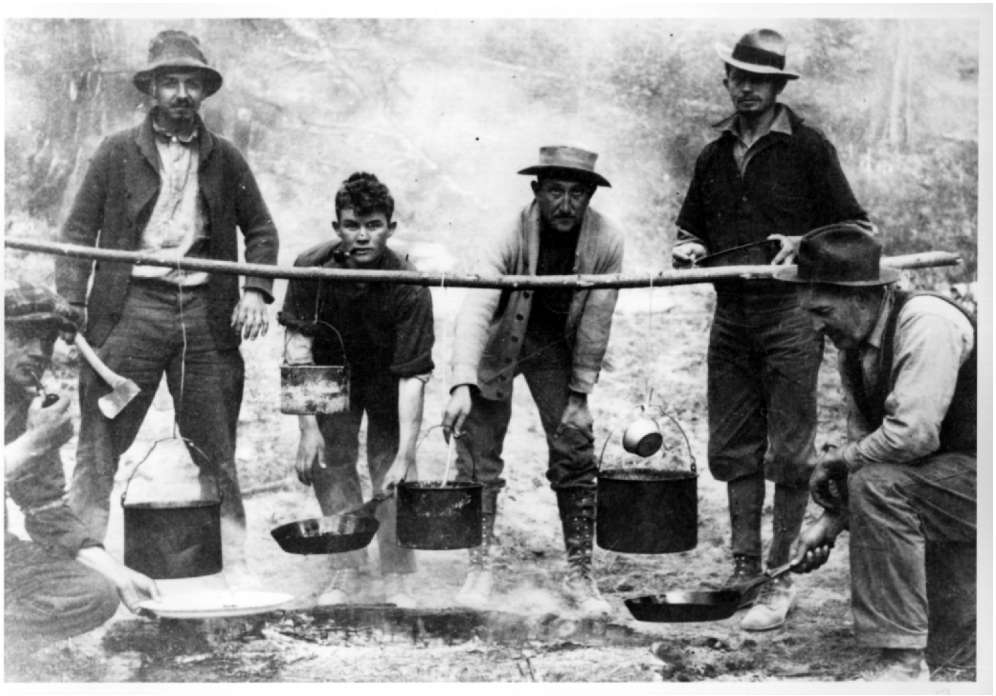


GLO Circular 119, published in 1887, defined proportionate measurement.

By "proportionate measurement" as used in this circular is meant a measurement having the same ratio to that recorded in the original field notes as the length of chain used in the new measurement has to the length of chain used in the original survey, assuming that the original measurement was correctly made.

Proportionate Measurement?

- Proportionate measurement is a distribution of the differences between an original measurement and a new measurement.
- Proportionate measurement should distribute the differences equally to every part of the line.
- Proportionate measurement is a good way to distribute systematic and random errors which result from two different measurements of a line or lines.

Systematic Errors

Result from some part of the system being a out of calibration. The most common example is the original surveyor's chain being a little too long or too short.

Random Errors

Happen unpredictably and because we are not perfect. An example would be the original surveyor not perfectly placing the chaining pin exactly at the distance measured.

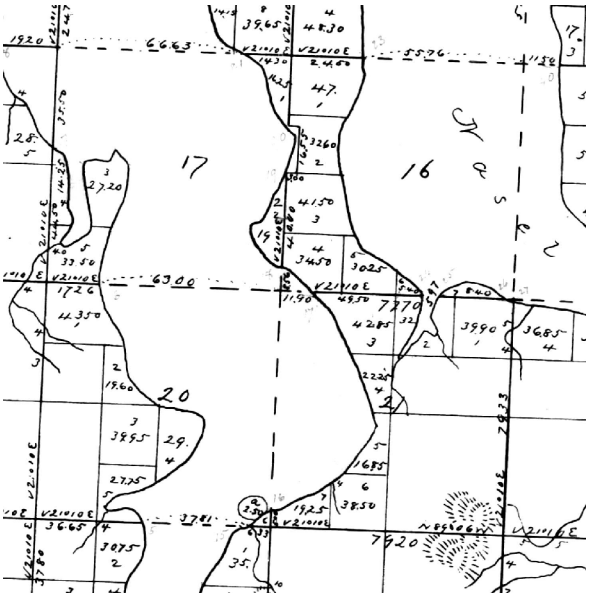
A Blunder

- Is distinguished from a systematic or random error by being a mistake. An example of a blunder would be the original surveyor miscounting the number of chains in the measurement of a line. This is very different from the random error created by not perfectly placing the chaining pin in the ground.
- Proportionate measurement is not intended to distribute errors caused by blunders.

Principle of Law

- An original surveyor's mistake which is identified the courts will consider placing the entire blunder where it occurred.
  - When it is obvious or unquestionably proven that the original surveyor made a blunder in his chaining, the amount of the blunder is corrected before any remaining discrepancies between the retracement and the original measurement are adjusted or proportioned.

An example of a blunder - A GLO plat surveyed by Mr. Gile

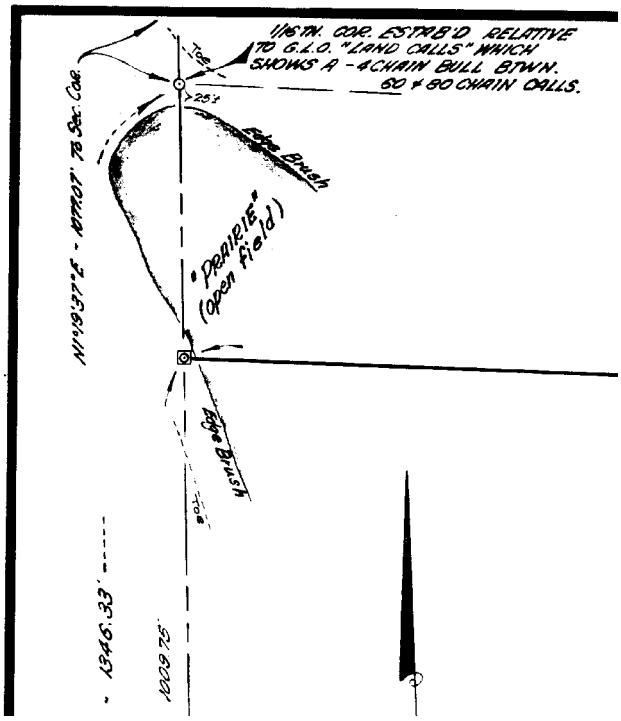


A letter from the Oregon State Office of the BLM regarding the lost section corner

"It appears Gile's measurements by triangulation have a significant amount or error. However, your measurements between found original corners indicate his chaining was good. He actually chained out to several of the corners which fell on the tidelands including the point for the corner of sections 16, 17, 20, and 21 where he set a flag to use for his triangulation to the south and west."

The letter continued

"Using double proportion to re-establish the corner point will put a considerable amount of distortion in the lines going north and east, distortion that undoubtedly was not in the original survey. Therefore, we feel the best method of re-establishing the point for the corner of sections 16, 17, 20, and 21 is by two point control at record departure from the found meander corner between sections 16 and 21, and at record latitude from the found meander corner between sections 16 and 17. This would leave some distortion, but we feel this method best protects the original survey."



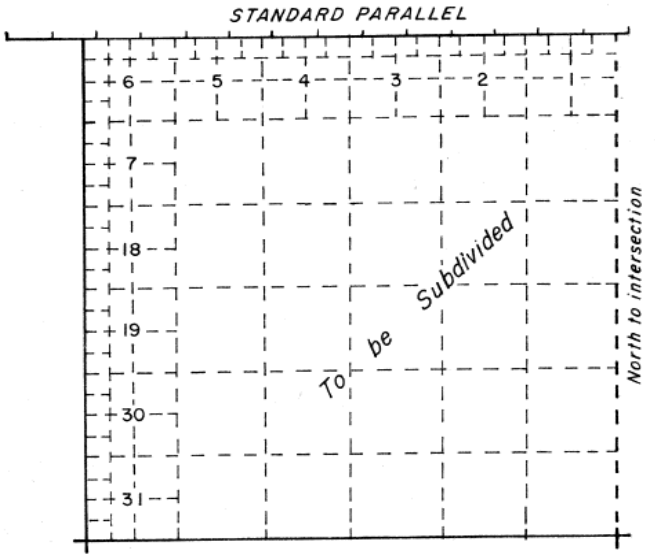
Should the 1/16 corner be established not at midpoint based on the location of a 4 chain measuring mistake by the original surveyor?

Summary of Proportioning Applications

When to Single Proportion (Manual 5-30)

- all standard corners
- all corners on township and range lines, except township corners
- corners on base lines, standard parallels, and correction lines
- 1/4 corners interior to a township
- meander corners (non-terminal)
- closing corners

Single proportion all standard corners and all corners on township and range lines, except township corners



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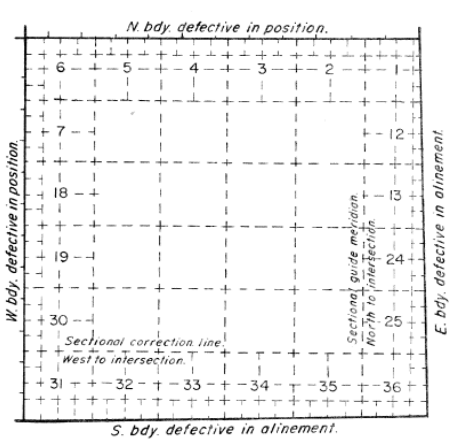
Single proportion corners on base lines, standard parallels, and correction lines



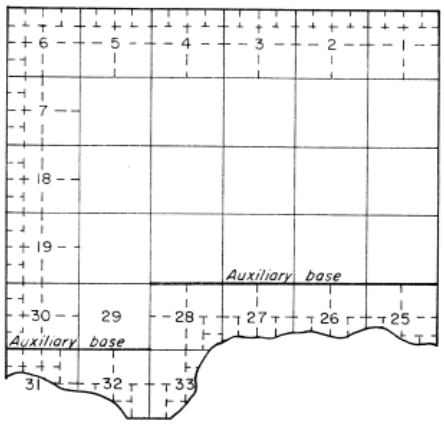


FIGURE 55(a).—Use of auxiliary base.

46

Single proportion 1/4 corners interior to a township

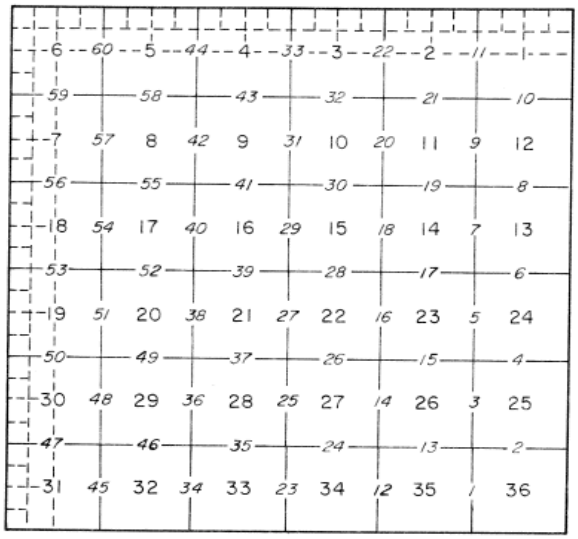
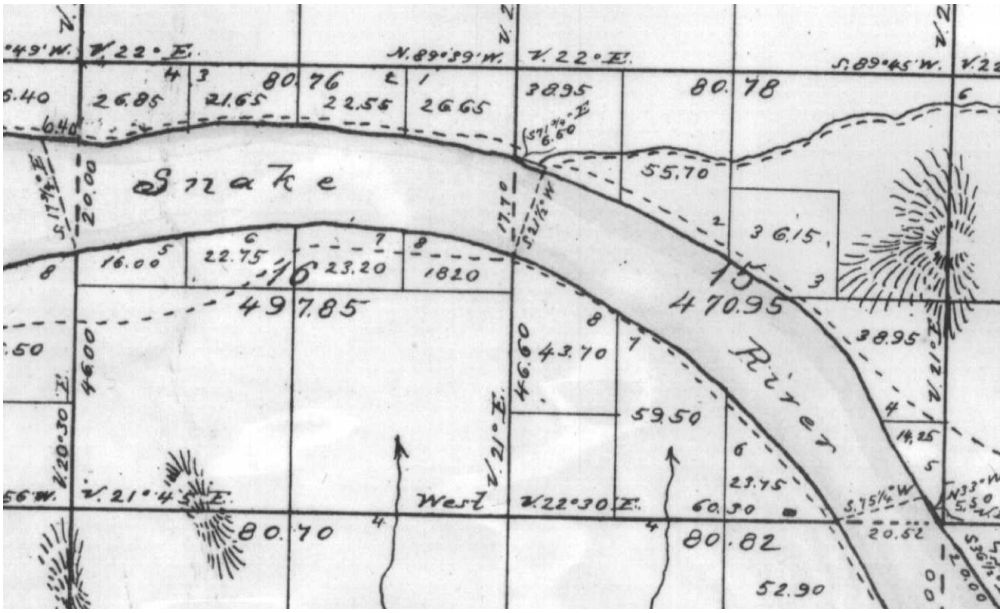
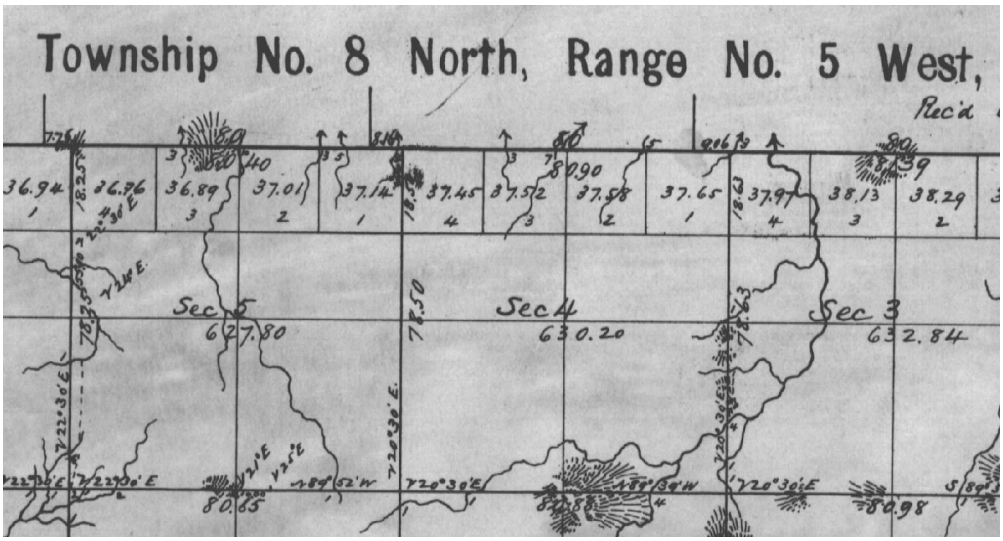


FIGURE 39.—Sequence of numbers on section lines shows normal order of subdivision.

Single proportion meander corners (non-terminal)

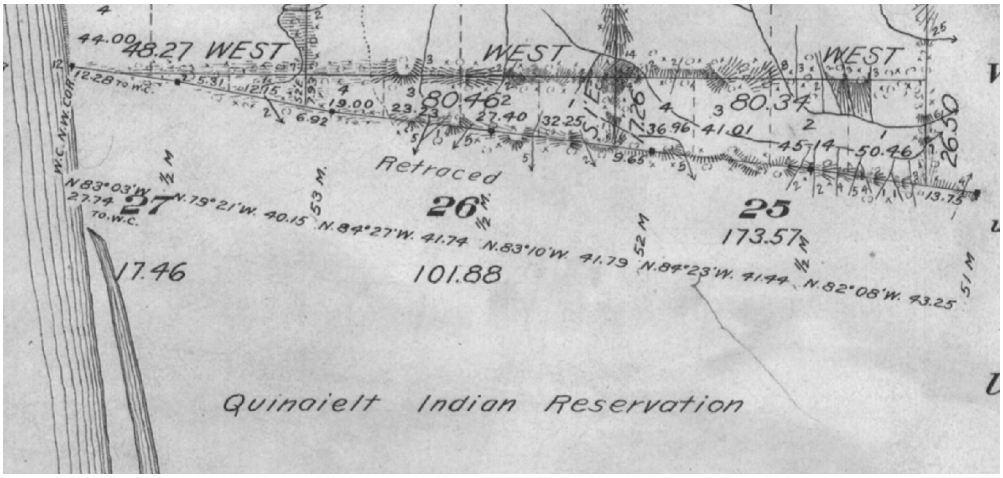


Single proportion closing corners



49

Single proportion closing corners



50

When to Single Proportion (Manual 5-30)

- all standard corners
- all corners on township and range lines, except township corners
- corners on base lines, standard parallels, and correction lines
- 1/4 corners interior to a township
- meander corners (non-terminal)
- closing corners

When to Double Proportion (Manual 5-25)

- township corner common to four townships
- section corners interior to a township

Double proportion township corners common to four townships

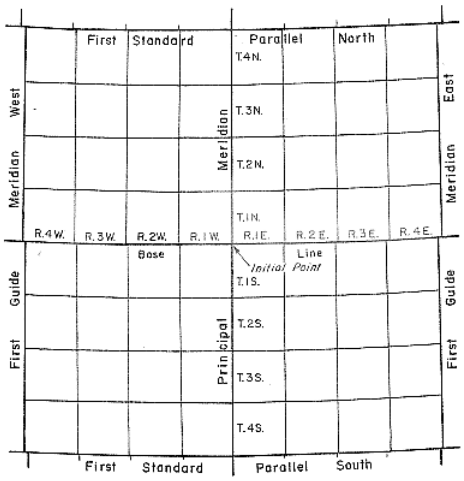


FIGURE 15.—Survey of quadrangles, each embracing 16 townships bounded by standard lines, showing the coordinate system of numbering townships.

Double proportion section corners interior to a township

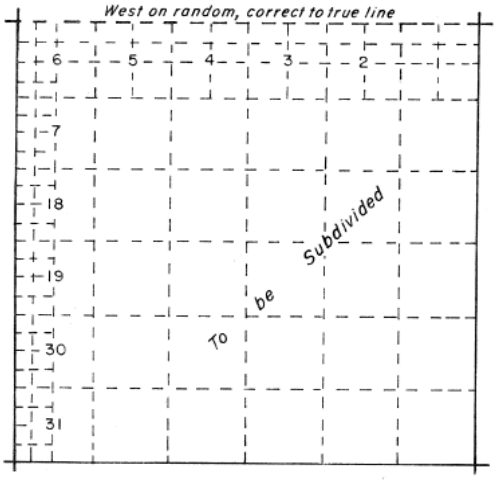
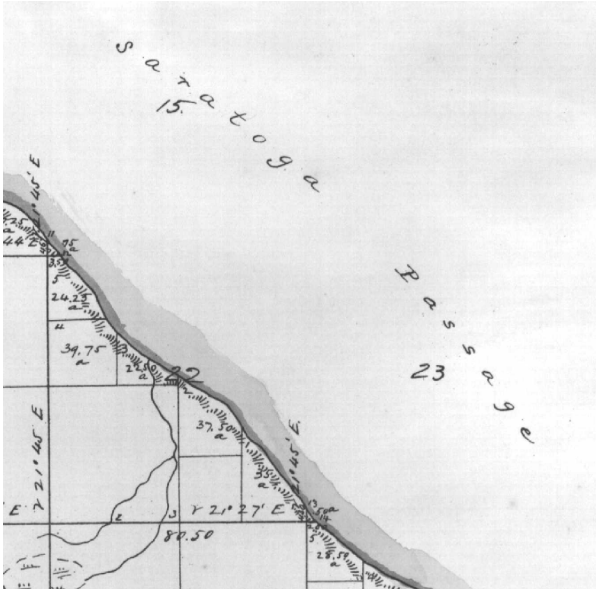


FIGURE 17.—Regular order of completing exteriors where south, east, and west boundaries previously surveyed.

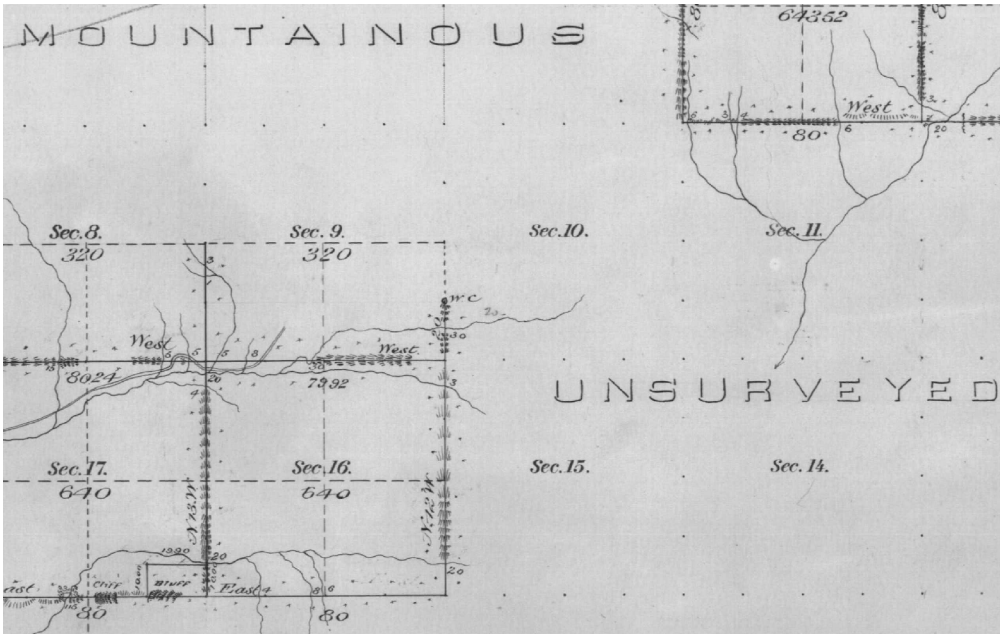
When to use Single Point Control (Manual 5-28,5-45)

- any corner set from only one direction (e.g. terminal meander corners)

The meander corners fronting Saratoga Passage below are terminal meander corners, meaning they are at the terminus of a surveyed line. They would be restored by single point control.



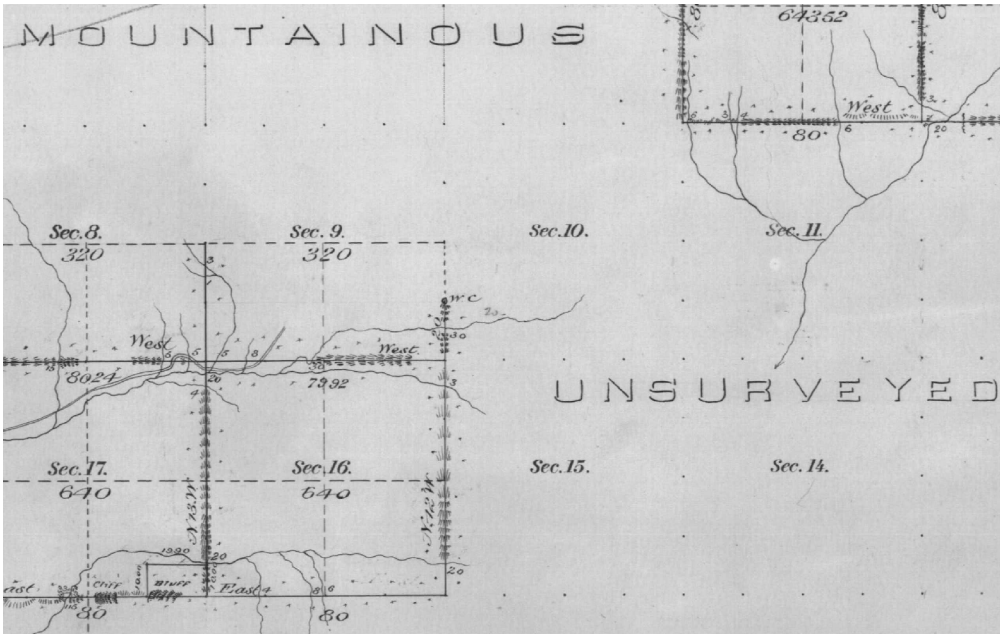
The quarter corner between sections 8 and 9 is at the end of a surveyed line and would be restored by single point control.



When to use Two Point Control (Manual 5-29)

- township or section corner on two surveyed lines only

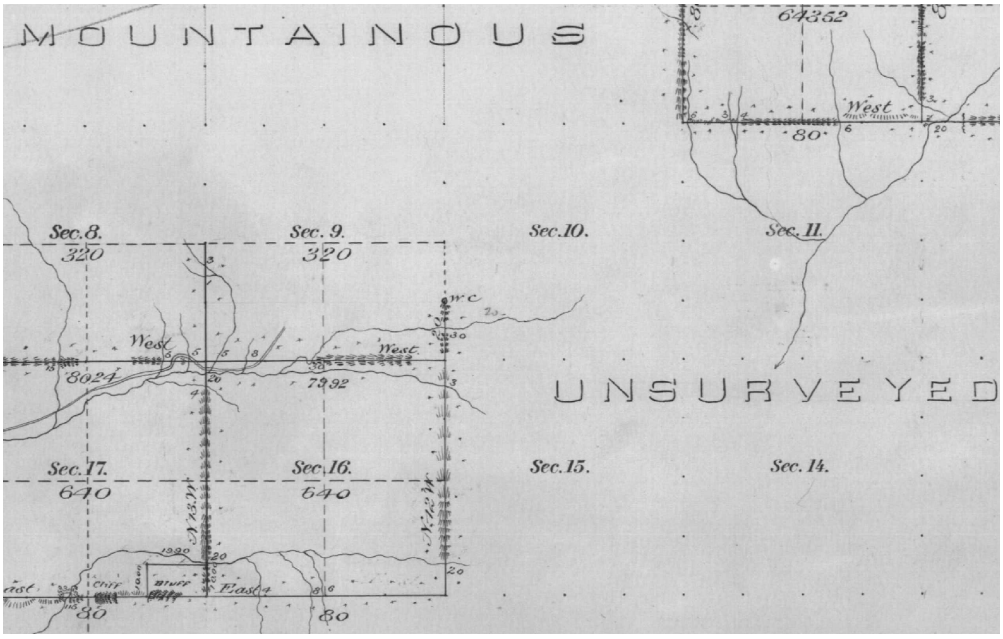
The southeast corner of section 16 is on two surveyed lines only and would be restored by two point control.



When to use Three Point Control (Extends the logic of Manual 5-29)

- township or section corner on three surveyed lines only

The southwest corner of section 16 is on three surveyed lines only and would be restored by three point control.

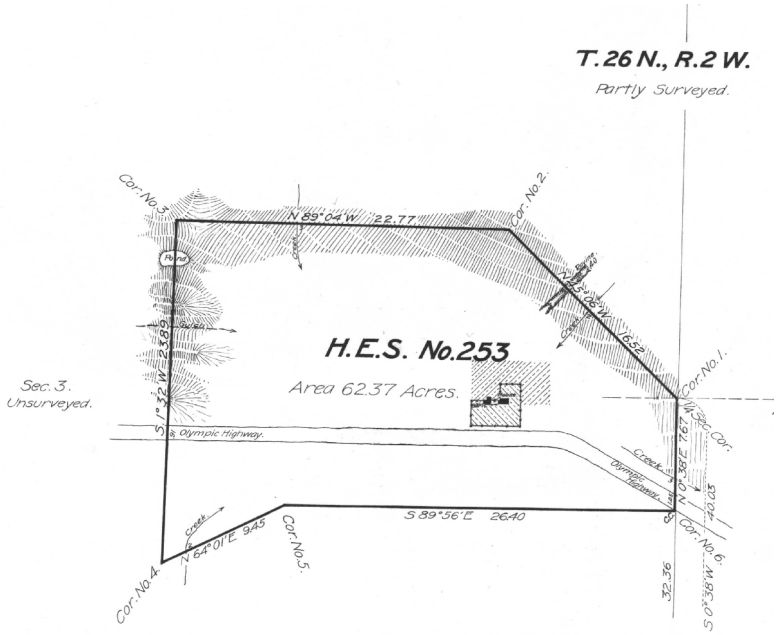


When to use the Grant Boundary Method (Manual 5-44)

Rotate and Scale

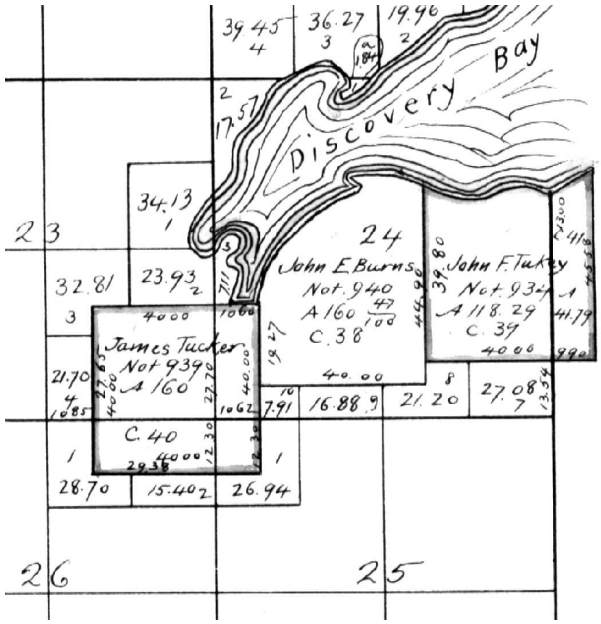
- donation land claims ?
- homestead entry surveys
- mineral surveys ?
- tract corners
- townsites
- military/Indian/etc. reservations
- state/international lines ?

Use the grant boundary method
for Homestead Entry Surveys. See Manual 5-44.



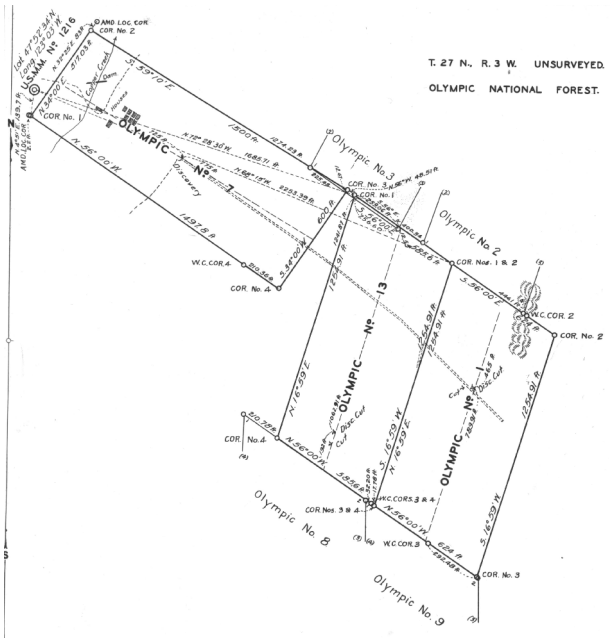
63

You might use the grant boundary method
for Donation Land Claim corners. See Manual 5-44.



64

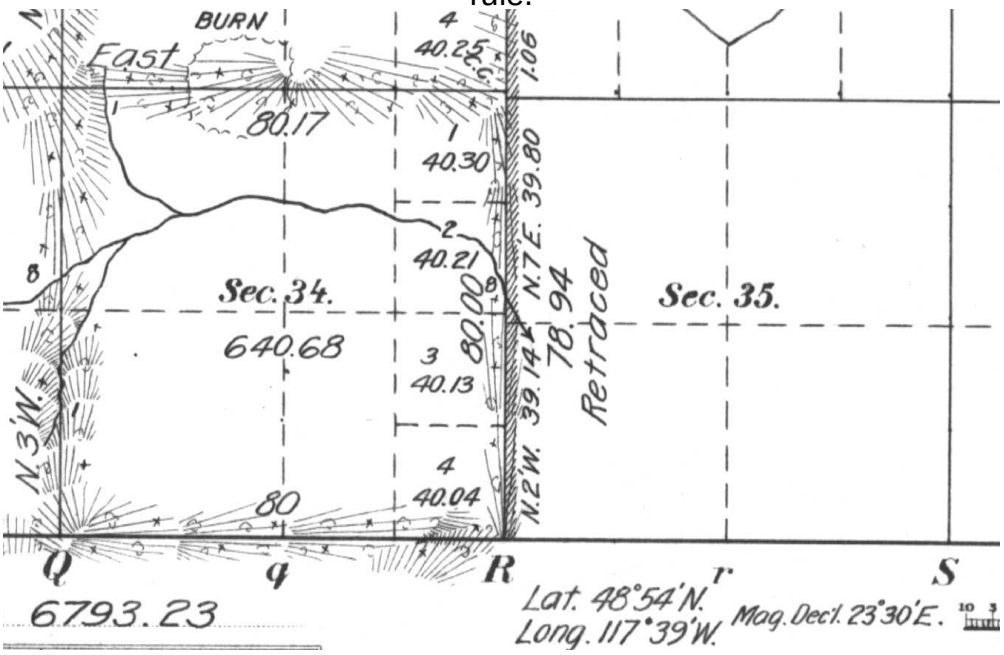
You might use the grant boundary method for Mineral Surveys. See Manual 5-44.



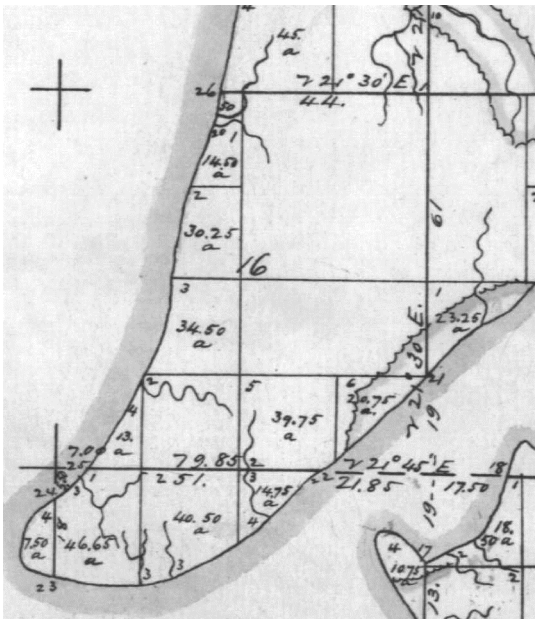
When to use Irregular Boundary Methods (Manual 5-36,5-43)

- mineral surveys ? (There are no set rules for the restoration of a lost mineral survey corner.)
- 1/4 corner on broken boundary of record
- non-riparian meander lines
- donation land claims ?

Use irregular boundary method for a 1/4 corner on a broken boundary of record. See Manual section 5-36. Almost the compass rule.



Use irregular boundary method for a non-riparian meander line. See Manual section 5-43. This is the compass rule.



Single Proportionate Measurement

BLM Manual 5-30. The term “single proportionate measurement” is applied to a new measurement made on a line to determine one or more positions on that line. By single proportionate measurement the position of two identified corners controls the direction of that line. The method is sometimes referred to as a "two-way" proportion, such as a north-and-south proportion or an east-and-west proportion.

Single Proportion Examples

BLM Manual 5-30 (continued)

Examples are

- *a quarter-section corner on the line between two section corners,*
- *all corners on standard parallels,*
- *and all corners occupying intermediate positions on a township boundary line.*

Single Proportion Method

BLM Manual 5-31. *In order to restore a lost corner on a line by single proportionate measurement,*

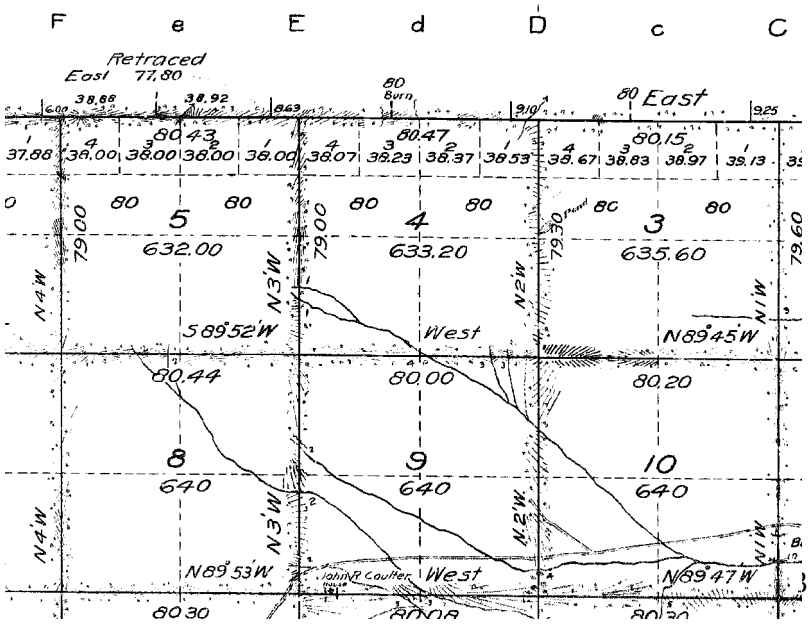
- *a retracement is made connecting the nearest identified corners on the line. These corners control the position of the lost corner. Control corners are usually corners established in the original survey of the line.*
- *The lost corner is then re-established at proportionate distance on the true line connecting the recovered corners.*
- *Proper adjustment is made on an east and west line to secure the latitudinal curve.*
- *Any number of intermediate lost corners may be located on the same plan.*

Remember

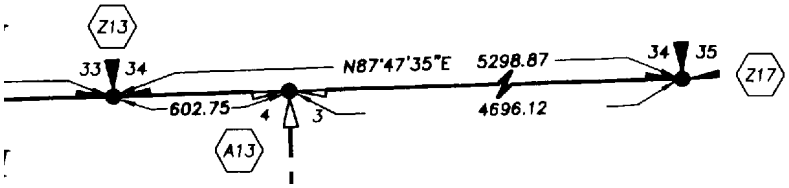
Many single proportion positions are not midpoints. Examples are closing corners along a township line and quarter corners connecting to the north and west township lines.

Single Proportion Example:

1896 GLO survey by Lewis D. W. Shelton, T34N, R38E



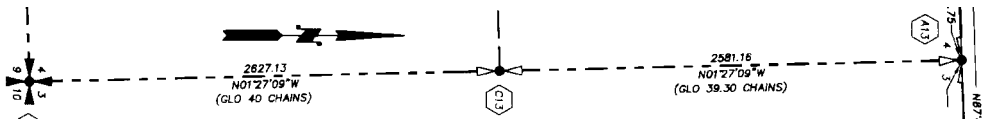
Single Proportion corner A13:
the Closing Corner of Sections 3 and 4



- The total GLO distance along the south boundary of Section 34 is 80 chains.
- The survey measurement is 5298.87 feet.
- The proportion of feet to chains is 5298.87 / 80 = 66.2358750 feet per chain.
- The GLO set the closing corner 9.10 chains east of the southwest corner of section 34.
- Therefore the single proportioned position is 9.10 x 5298.87 / 80 = 602.75 feet east of the southwest corner of section 34.

Single Proportion corner C13:

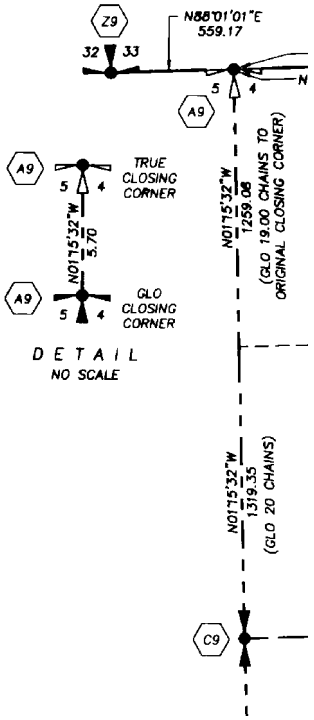
the Quarter corner between Sections 3 and 4



- The total GLO distance along the section line is 79.30 chains, with 40 chains south of the 1/4 corner and 39.30 chains north of the 1/4 corner.
- The survey measurement is 5208.29 feet.
- The proportion of feet to chains is 5208.29 / 79.30 = 65.67831021 feet per chain.
- The proportioned distance south of the 1/4 corner is 40 x 5208.29 / 79.30 = 2627.13.
- The proportioned distance north of the 1/4 corner is 39.30 x 5208.29 / 79.30 = 2581.16.

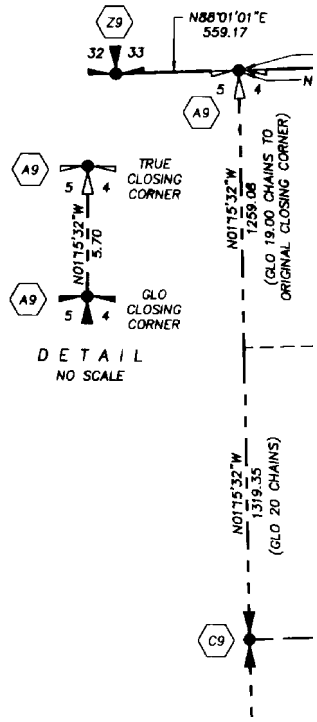
Closing Corner found off line

Note: When the original closing corner is found off the line closed upon, as with the closing corner of sections 5 and 4 in the example survey to the right, all proportioning is done to the original closing corner, not to the true closing corner.

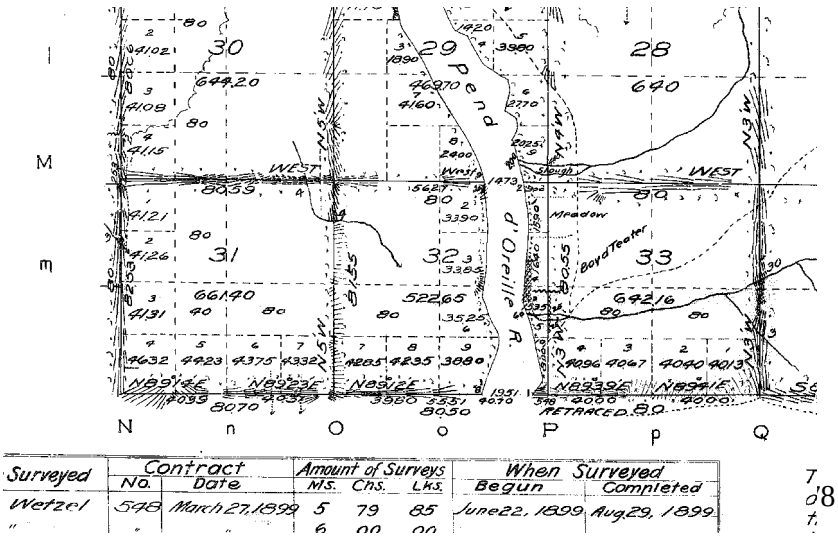


Single Proportion Calculation to Original Closing Corner

- GLO distance from ¼ corner to closing corner is 39.00 chains.
- Measured distance is 1319.35 + 1259.08 – 5.70 = 2572.73 feet.
- Proportioned distance from ¼ corner to north 1/16 corner = 20.00 x 2572.73 / 39.00 = 1319.35 feet.
- Proportioned distance from north 1/16 corner to original closing corner = 19.00 x 2572.73 / 39.00 = 1253.38 feet.
- Total distance from north 1/16 corner to the true closing corner on the township line = 1253.38 + 5.70 = 1259.08 feet.



Single Proportion along a Sectional Correction Line: T 35 N, R 44 E, Pend Oreille County



Surveyed	Contract No.	Contract Date	Amount of Surveys Ms.	Amount of Surveys Chs.	Amount of Surveys Lks.	When Surveyed Begun	When Surveyed Completed
Wetzel	548	March 27, 1899	5	79	85	June 22, 1899	Aug. 29, 1899
"	"	"	6	00	00		

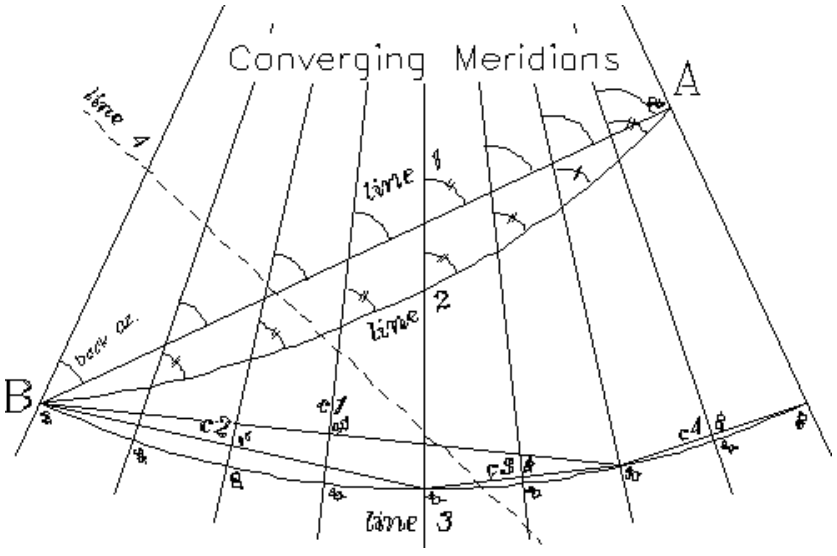
From the GLO Notes

Subdivision of T. 35 N. R. 44 E. W. M.

Having previously ascertained that the west half of the south bdy of this township is out of limits in alignment I go to the cor of secs 27, 28, 33, and 34 and at 7 h. m. l. m. t. on Aug 3rd I set off 48° 29' on the lat. arc and 17° 29' Non the decl. arc and determine a true meridian with the solar

Thence I run West on a true line bet secs. 28 and 33, 29 and 32, 30 and 31 and establish 2 sectional corrections line.

Offset to the Latitudinal Curve



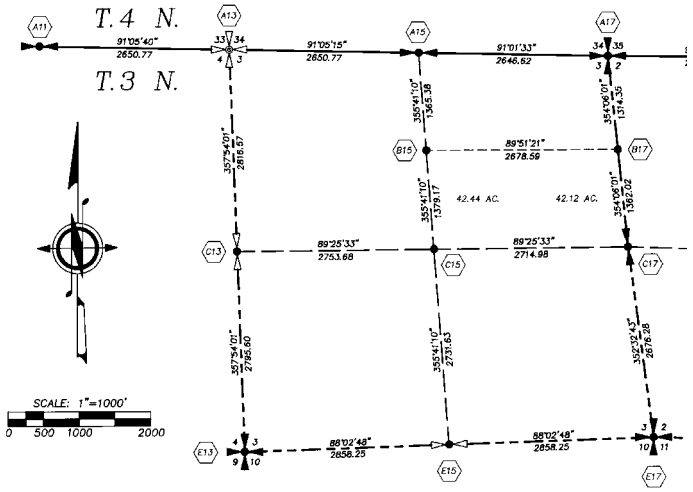
Offset to the Latitudinal Curve

Using the method set out in POB Tech tips by Elgin, Knowles & Senne

- Offset = (0.6668) (LW) (LE) (Tan Latitude)
- Where: - Offset is in feet from the single proportioned point on a straight line, e.g. chord or secant of the latitudinal curve.
- 0.6668 is a constant derived to make this equation simpler than it might be.
- LW is the distance west, <u>in miles</u>, from the single proportioned point to the known point.
- LE is the distance east, <u>in miles</u>, from the single proportioned point to the known point.

Latitudinal Curve Example

Township 3 North, Range 12 East



BASIS OF MERIDIAN

GPS TIES TO NGS HIGH PRECISION NETWORK CONTROL STATIONS DALLESPORT AND PONDER 2. WE ARE USING THE WASHINGTON COORDINATE SYSTEM, NAD 83/1991 SOUTH ZONE FOR THIS PROJECT.

DESCRIPTION OF STATE LAND SURVEYED

GOV'T LOTS 1,2 AND 4; SW 1/4 of the NE 1/4; SW 1/4 of the NW 1/4; OF SECTION 1, T3N R12E, W.M.

Section Corner A13

- Needs to be single proportioned between corners A11 and A15.
- The GLO distances are exactly 40 chains each from A11 to A13 and A13 to A15.
- The bearing is east.

"x" is the proportioned point on a straight line.

A11 165,014.6400 1,433,246.1360

S88°54'33"E 2650.770

X 164,964.1716 1,435,896.4260

S88°54'33"E 2650.770

A15 164,913.7032 1,438,546.7160

Now compute the offset to latitudinal curve.

Offset = (0.6668) (LW) (LE) (Tan Latitude) = (0.6668) (1/2 mile) (1/2 mile) (tan 45°46'58") = 0.17 feet

Bearing of Offset is Due South. Convergence is -0°34'56", so due south is S 0°34'56" W.

Calculate Offset:

x: 164,964.1716 1,435,896.4260 --> S 0°34'56" W 0.170 --> A13: 164,964.0016 1,435,896.4243

Inverse between Corners:

A11: 165,014.6400 1,433,246.1360
S88°54'19"E 2650.772
A13: 164,964.0016 1,435,896.4243
S88°54'46"E 2650.769
A15: 164,913.7032 1,438,546.7160

Alternate Calculation for Proportioning along the Latitudinal Curve

- The position can be derived from a simple single proportion calculation using latitude and longitude instead of plane coordinates.
- Convert to seconds of arc for proportioning.
- Care must be taken to use sufficient precision in the calculations, about 8 or 9 decimal places of decimal degrees.

Double Proportion

BLM Manual

5-25. *Lengths of proportioned lines are comparable only when reduced to their cardinal equivalents.*

5-26. *In order to restore a lost corner of four townships, a retracement will first be made between the nearest known corners on the meridional line, north and south of the missing corner, and upon that line a temporary stake will be placed at the proper proportionate distance; this will determine the latitude of the lost corner.*

Double Proportion

5-26. *(cont.)*

Next, the nearest corners on the latitudinal line will be connected, and a second point will be marked for the proportionate measurement east and west; this point will determine the position of the lost corner in departure (or longitude).

Then, through the first temporary stake run a line east or west, and through the second temporary stake a line north or south, as relative situations may determine; the intersection of these two lines will fix the position for the restored corner.

Cardinal Equivalents?

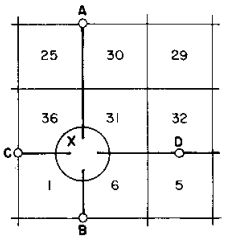
- Only the easterly component (departure) of the E-W controlling record line is used to compute the E-W proportion position, and only the northerly component (latitude) of the N-S record is used to compute the N-S position.
- This is a different ratio than if using the *lengths* of the record lines.

Double Proportion in 3 Steps

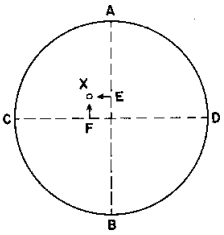
1. Single proportion between controlling corners for a temporary N-S position by cardinal equivalents
   (will control or “lock” final position of latitude)

2. Single proportion for a temporary E-W position
   (will control final position in departure)

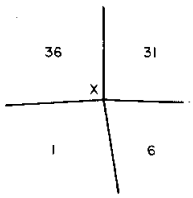
3. Intersect for true double proportion position by cardinal offsets from each temporary point



Lost township corner in vicinity of X

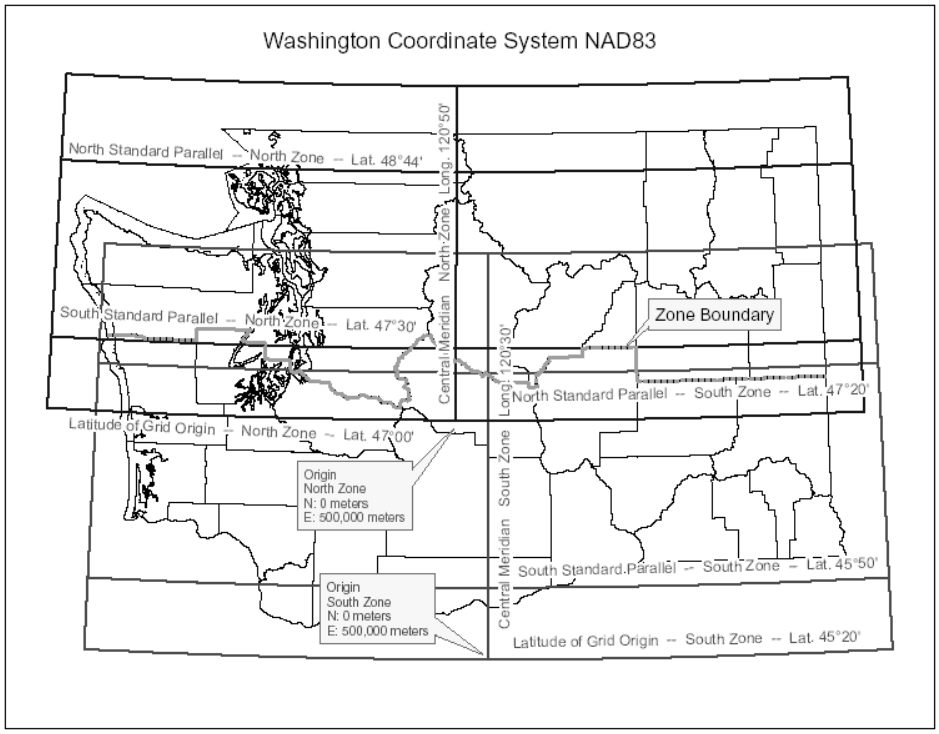


A,B,C,D—Control corners
E—Proportionate point for X in latitude between A and B
F—Proportionate point for X in departure between C and D
Correct position of X is at intersection of lines extended East or West from E, North or South from F.



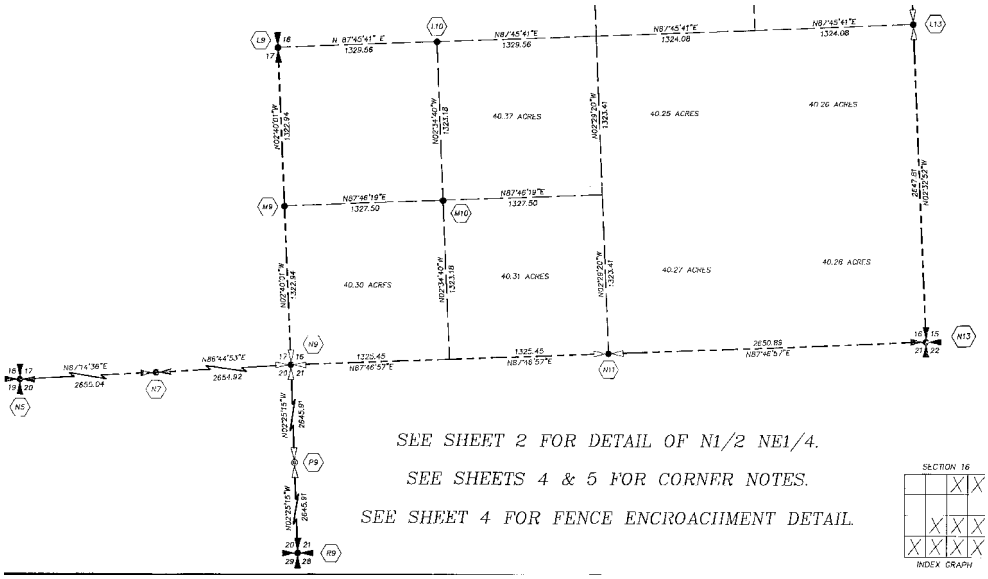
Restored corner showing true direction of township lines

FIGURE 70.—Double proportionate measurement.



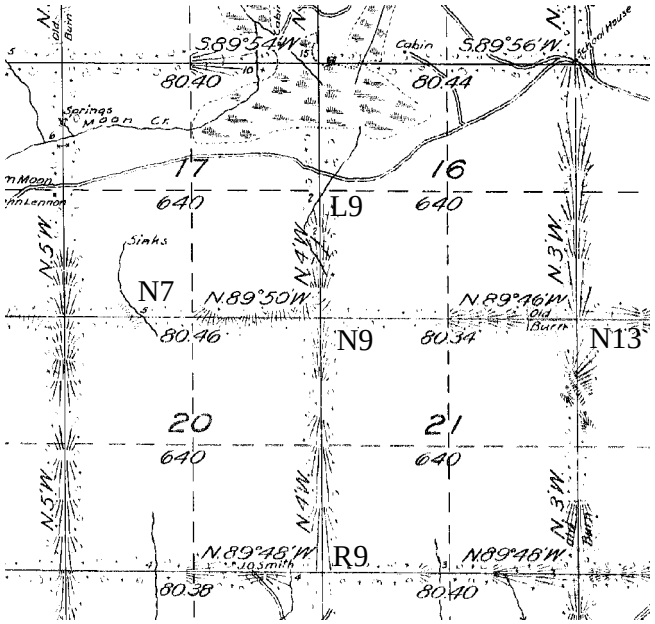
Double Proportion Example

Section 16, T30N, R44E



GLO Plat

Section 16, T30N, R44E



Cardinal Equivalents of E-W Lines

- N89°46’W, 80.34 chs.

  (Lat. + 0.3272 Dep. – **80.3393**)

- N89°50’W, 40.23 chs.

  (Lat. + 0.1170 Dep. – **40.2298**)

120.5691 chs.

Total departure for E-W proportioning

Cardinal Equivalents of N-S Lines

- N00°04’W, 80.00 chs.

  (Lat. + **79.9999** Dep. – 0.0931)

- N00°04’W, 40.00 chs.

  (Lat. + **40.0000** Dep. – 0.0465

119.9999 chs.

Total latitude for N-S proportioning

Double Proportion Calculation

L9: 420,362.066 / 2,512,679.621
N7: 417,568.444 / 2,510,152.087
N13: 417,924.181 / 2,518,100.550
R9: 412,431.941 / 2,513,026.260

L9 to R9 = S 2°30'10"E 7937.697 feet, 120 chains G LO.
N7 to N13 = N87°26'15"E 7956.420 feet, 120.57 chain s
(120.57 = 80.46/2 + 80.34)

North/South proportion = 7937.697 / 120 = 66.1641 feet/ch
North/South distances are 40 x 7937.697/120 = 2645.899
and 80 x 7937.697/120 = 5291.798

East/West proportion = 7956.420 / 120.57 = 65.9900 feet/ch
East/West distances are 40.23x7956.420/120.57=2654.780
and 80.34 x 7956.420/120.57 = 5301.640

Double Proportion Calculation

L9 420,362.0660 2,512,679.6210
S 2°30'10"E 2645.89 9
y 417,718.6912 2,512,795.1673 = temp north south point
S 2°30'10"E 5291.79 8
R9 412,431.9410 2,513,026.2600

N7 417,568.4440 2,510,152.0870
N87°26'15"E 2654.780
x 417,687.1410 2,512,804.2122 = temp east west point
N87°26'15"E 5301.640
N13 417,924.1810 2,518,100.5500

Calculate Direction of Cardinal Offsets

U.S. Army Topo. Engineering Center, CORPSCON

y	417,718.69120 N	
	2,512,795.16730 E	
Convergence	+02 39 30.79525	
Scale Factor	0.999942375	
x	417,687.14100 N	
	2,512,804.21220 E	
Convergence	+02 39 30.87829	
Scale Factor	0.999942375	

Grid Azimuth = True Azimuth minus Convergence
True north 0° = grid 357°20’29” = N 2°39’31”W
True east 90° = grid 87°20’29” = N 87°20’29”E

In most of eastern Washington convergence is positive.
In all of western Washington convergence is negative.

Double Proportion Calculation

Intersection of cardinal lines from temporary points

Pt	Bearing	Distance	Pt
x	N 2°39'31"W	31.936	z
y	N87°20'29"E	7.572	z

Double Proportion Solution:
z = N:417719.0424 E:2512802.7308

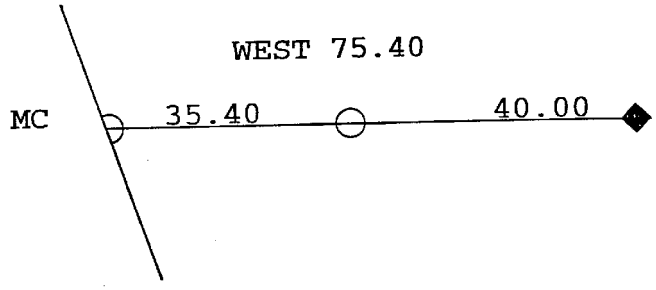
Inverses to controlling corners.
L9 to z = S 2°40'01"E 2645.889
N7 to z = N86°44'53"E 2654.919
N13 to z = S87°46'57"W 5301.789
R9 to z = N 2°25'15"W 5291.824

One Point Control

BLM Manual 5-45. *Original Control*

Where a line has been terminated with measurement in one direction only, a lost corner will be restored by record bearing and distance, counting from the nearest regular corner, the latter having been duly identified or restored.

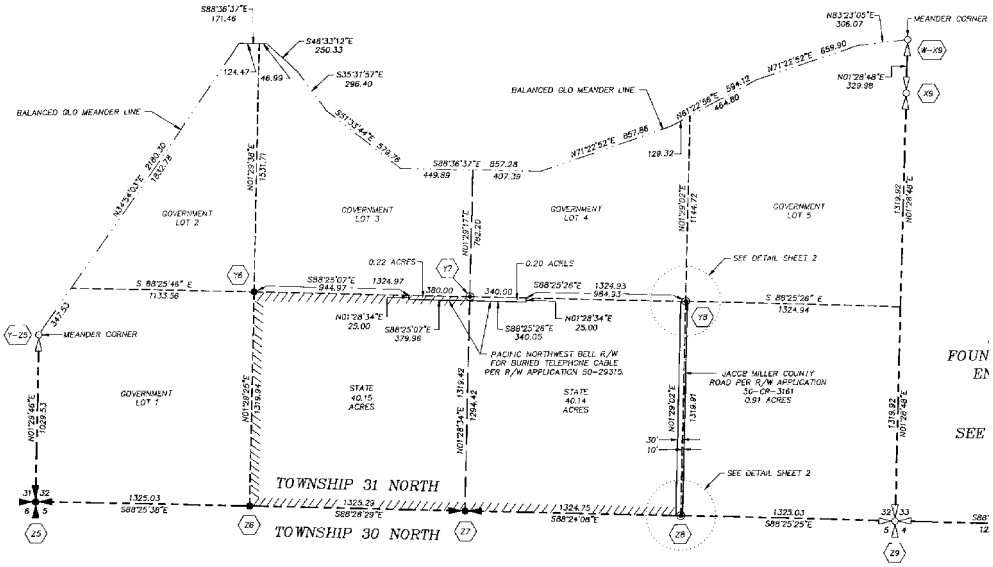
1 POINT CONTROL



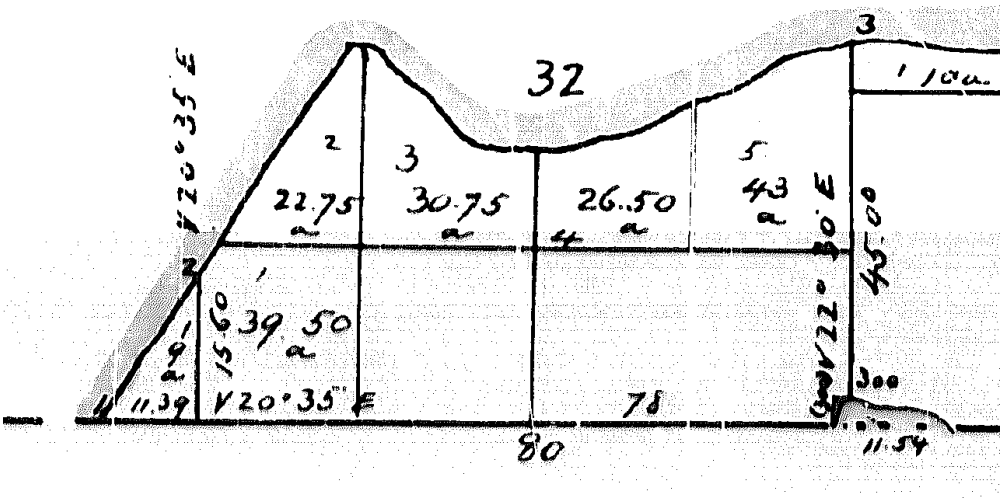
To restore the lost MC and 1/4 cor. use "1 Point Control" which is record bearing and distance.

CAUTION: If you are not on the same basis of bearing (true mean astronomic) as the record, you may end up in the wrong place.

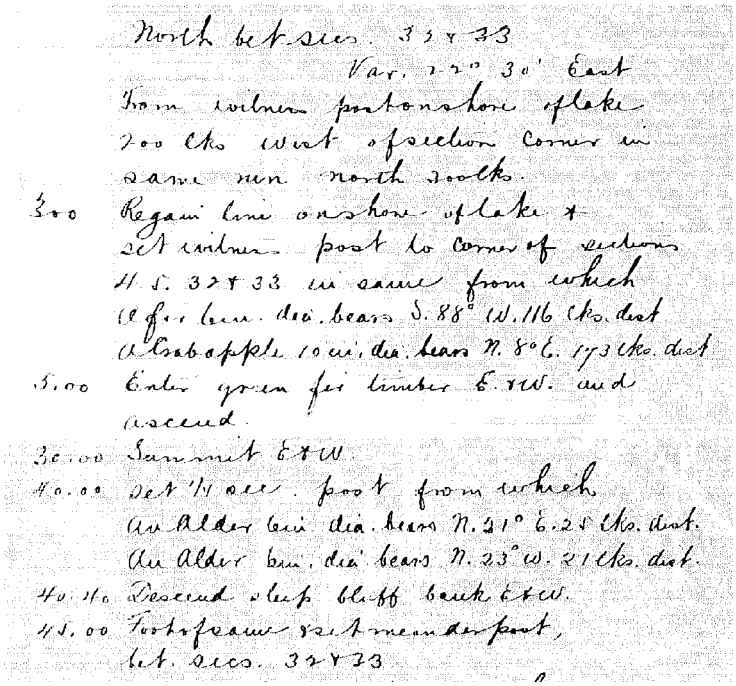
One Point Control Example Terminal Meander Corners



GLO Plat of Section 32, T31N, R1W



GLO Notes for Sec. 32, T31N, R1W



North bet secs. 32 & 33
Var. 22° 30' East
From witness post on shore of lake
200 chs west of section corner in
same run north 200 lks.
3.00 Regain line on shore of lake &
set witness post to corner of sections
N.S. 32 & 33 in same from which
10 fir brs. dia. bears S. 88° W. 116 lks. dist
a Crab apple 10 in. dia. bears N. 8° E. 173 lks. dist
5.00 Enter open fir timber S. 22 W. and
ascend.
30.00 Summit S & W.
40.00 Set N 32 33 post from which
an Alder brs dia. bears N. 21° E. 25 lks. dist.
an Alder brs. dia bears N. 23° W. 21 lks. dist.
40.50 Descend steep bluff back S & W.
41.00 Fortyfeam wet meander post,
bet. secs. 32 & 33

Calculate the two lost meander corners for Section 32 by one point control.

First figure the convergence angle at the two controlling section corners.

Name	Input	Output
Z5	418,066.52830 N	48 07 42.75348 N
	1,149,715.80420 E	122 50 34.43272 W
	Convergence	-01 29 46.18221
	Scale Factor	0.999942271

Z9	417,920.73130 N	48 07 42.67294 N
	1,155,013.89900 E	122 49 16.30200 W
	Convergence	-01 28 48.01230
	Scale Factor	0.999942271

U.S. Army Topo. Engineering Center, CORPSCON

Calculate the two lost meander corners for Section 32 by one point control.

Apply convergence (mapping angle) and combined grid scale factor to the record GLO measurements.

From Z5 the meander corner is N 1°29’46”E, 1029.53 feet.

0.9999361 x 15.60 chains x 66 ft/ch = 1029.53.

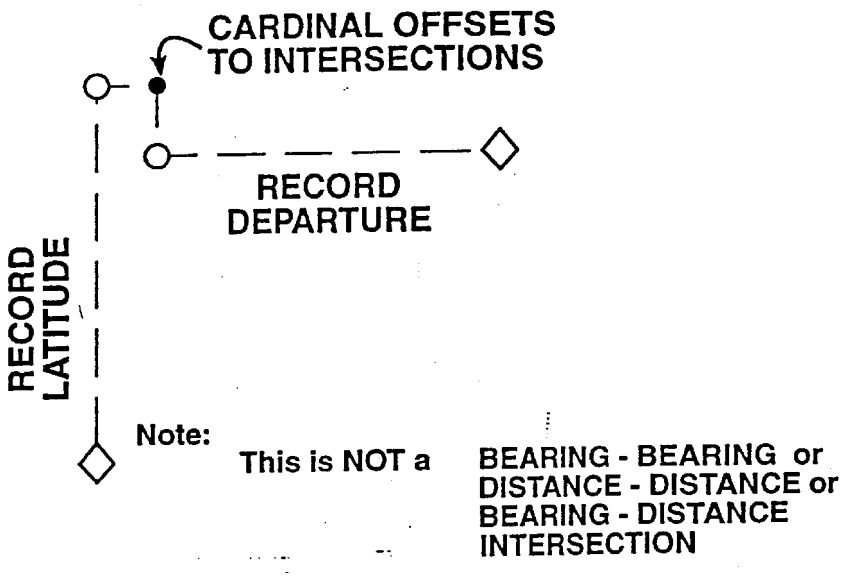
From Z9 the 1/4 corner, X9, is N 1°28’48”E, 2639.83 feet.

0.9999361 x 40 chains x 66 ft/ch = 2639.83.

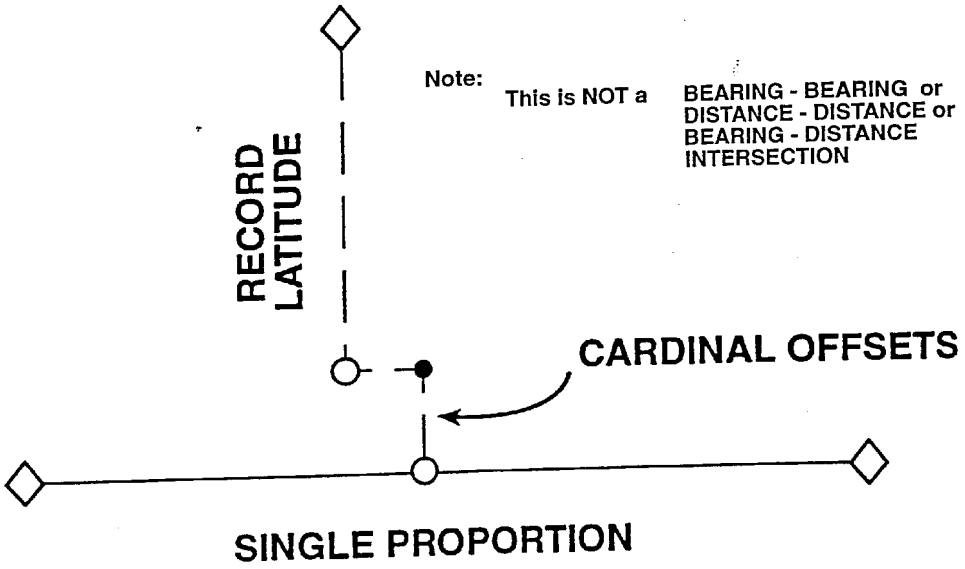
From the 1/4 corner, X9, the meander corner is N 1°28’48”E 329.98 feet.

0.9999361 x 5 chains x 66 ft/ch = 329.98.

2 POINT CONTROL

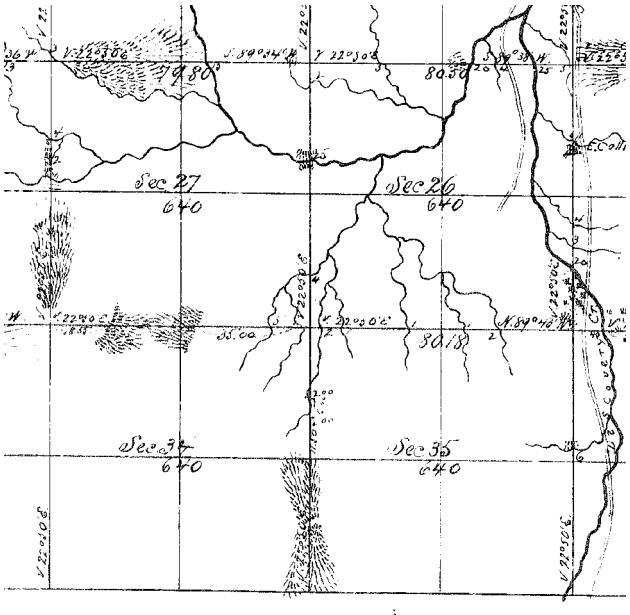


3 POINT CONTROL



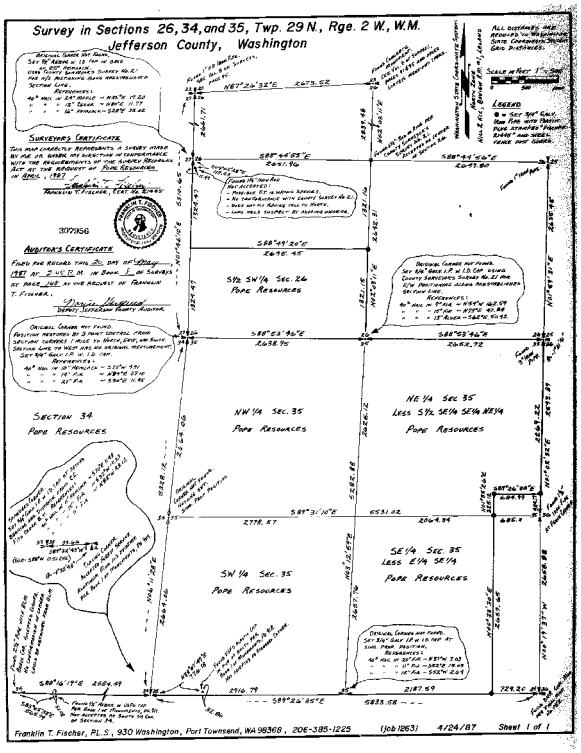
Three Point Control Example

GLO Plat T29N, R2W, W.M.



The line between sections 27 and 34 was only partially measured. The section line monument 35.00 chains west of the corner of sections 26, 27, 34, and 35 is lost.

3 Way Proportion of the corner common to Sections 26, 27, 34 and 35



Calculate 3 Way Proportion of the corner common to Sections 26, 27, 34 and 35

The north and south proportion

This is a single proportion. The GLO measure is 80 chains for each mile.

337 355,018.6470 1,491,453.4560
N 3°59'02"E 5315.427
x 360,321.2305 1,491,822.7495
= temporary point north and south
N 3°59'02"E 5315.427
3252 365,623.8140 1,492,192.0430

Calculate 3 Way Proportion of the corner common to Sections 26, 27, 34 and 35

Single point control from NE corner of Section 35.
Northeast corner of section 35
83 360,213.74000 N 47 58 08.89751 N
1,497,318.74600 E 122 53 08.00494 W
Convergence -01 31 40.51994
Scale Factor 0.999945613
GLO is N89°40'W, 80.18 chains.

We are close to sea level so apply convergence of minus 1°31'41"
and scale factor of 0.9999456.
83 360,213.74000 1,497,318.7460
N88°28'19"W 5291.590
y 360,354.8497 1,492,029.0378 = temporary point east and west

Calculate 3 Way Proportion of the corner common to Sections 26, 27, 34 and 35

Now compute convergence and do cardinal intersection.

y 360,354.8497 N 1,492,029.0378 E
Convergence -01 32 38.41559 Scale Factor 0.999945614
x 360,321.23050 1,491,822.7495
S88°27'22"E 205.308
z 360,315.6990 1,492,027.9826 = corner by 3 way prop
N 1°32'38"E 39.163
y 360,354.8497 1,492,029.0378

Inverse to controlling corners.
z 360,315.6990 1,492,027.9826
S88°53'46"E 5291.746
Side Shot to #83 360,213.74000 1,497,318.7460
S 6°11'25"W 5328.118
Side Shot to #337 355,018.64700 1,491,453.4560
N 1°46'13"E 5310.650
Side Shot to #3252 365,623.81400 1,492,192.043

Meander Lines and Grant Boundaries

- Compass Rule for Meander Lines
- Rotate and Scale Grant Boundaries
- Donation Land Claims can be done both ways

Non-Riparian Meander Lines

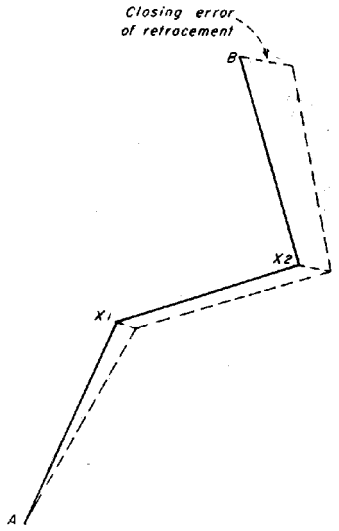
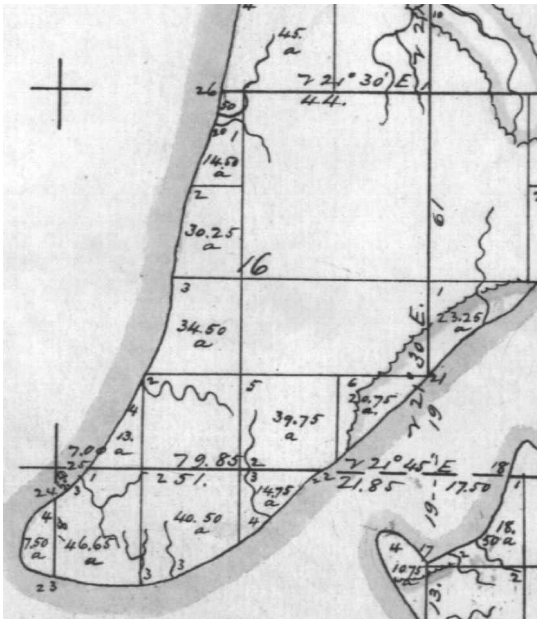


FIGURE 72.—Adjusting angle points on a nonriparian meander line.

Meander Line Adjustment
Section 16, T16N, R11W



GLO Record of the Meander Line

Thence on Sect 16

N 33 E 22.00 ch. a branch 25 lks wide runs West

N 20 E 13.00 ch.

N 10 E 26.00 ch.

N 24 E 22.00 ch. 18.00 ch. along gl 20 lks wide runs West
20.50 ch. along gl 3. lks wide runs East

N 5 E 3.40 ch. Thence on true Sect 9+16

First enter the record courses using GLO bearings and distances scaled by the combined scale factor of 0.9999361.

2 579,067.8960 750,488.6570 MC16/21
N33°00'00"E 1451.900 (22.00 chains)
24 580,285.5618 751,279.4184
N20°00'00"E 857.940 (13.00 chains)
25 581,091.7617 751,572.8512
N10°00'00"E 1715.880 (26.00 chains)
26 582,781.5736 751,870.8106
N20°00'00"E 1451.900 (22.00 chains)
27 584,145.9133 752,367.3897
N 5°00'00"E 224.380 (3.40 chains)
28 584,369.4395 752,386.9457

Next calculate the convergence at the meander corner between sections 16 and 21.

MC 16/21 57,9067.89600 N 46 51 58.31630 N
750,488.65700 E 124 03 32.60205 W
Convergence -02 35 07.02011
Scale Factor 0.999926616

U.S. Army Topo. Engineering Center, CORPSCON 5.11.05

Next rotate by convergence at the meander corner between sections 16 and 21.

2	579,067.8960	750,488.6570	MC16/21
		N35°35'07"E 1451.900	
24	580,248.6541	751,333.5380	
		N22°35'07"E 857.940	
25	581,040.7978	751,663.0368	
		N12°35'07"E 1715.880	
26	582,715.4500	752,036.9141	
		N22°35'07"E 1451.900	
27	584,056.0022	752,594.5280	
		N 7°35'07"E 224.380	
28	584,278.4188	752,624.1466	
		N44°14'39"W 126.472	<- misclosure
15	584,369.0200	752,535.9050	MC9/16

Next, adjust using the compass rule

2	579,067.8960	750,488.6570	MC16/21
		N34°20'22"E 1457.931	
24	580,271.7239	751,311.0690	
		N21°25'38"E 865.604	
25	581,077.4997	751,627.2907	
		N11°32'04"E 1736.995	
26	582,779.4162	751,974.6139	
		N21°25'38"E 1464.870	
27	584,143.0382	752,509.7589	
		N 6°35'59"E 227.489	
28	584,369.0200	752,535.9050	
		N45°00'00"W 0.000	
15	584,369.0200	752,535.9050	MC9/1

Grant Boundaries

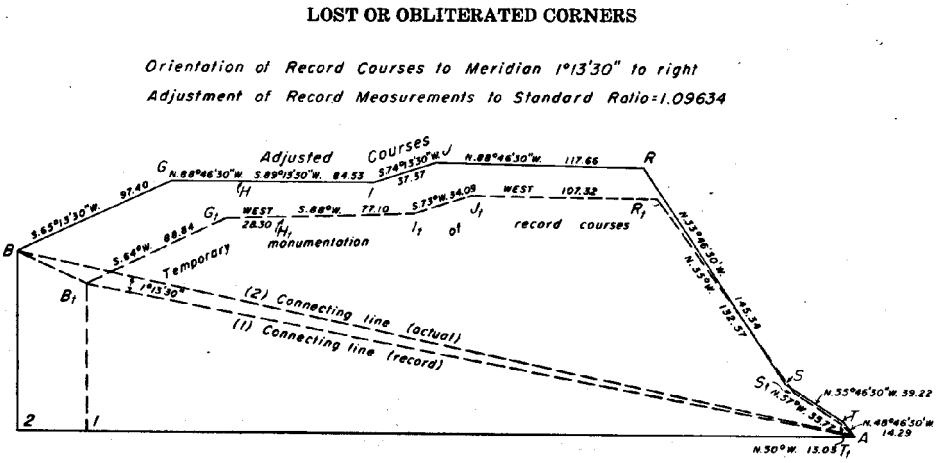


FIGURE 73.—Adjusting a grant boundary.

Figure 71. – Irregular exterior resulting from the piece-meal survey of a township line. (See page 137 of the Manual)

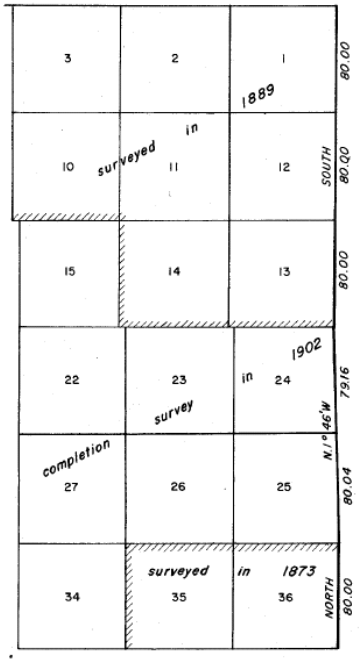
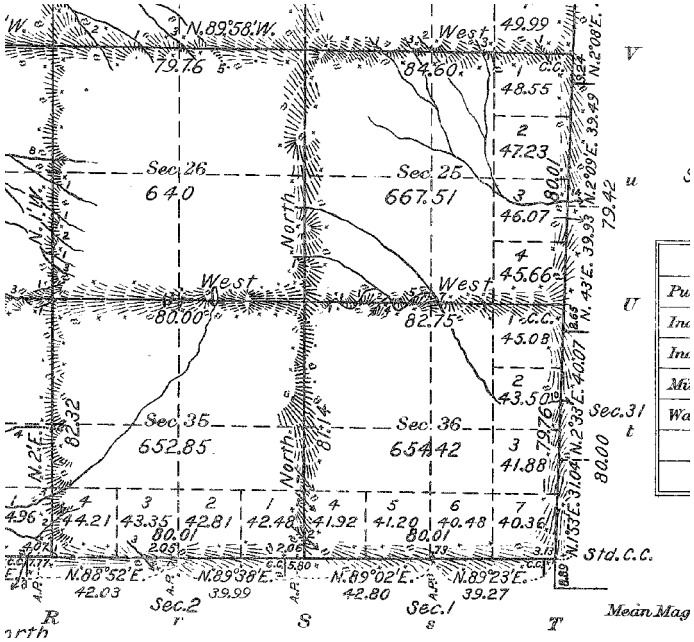


FIGURE 71.—Irregular exterior resulting from the piece-meal survey of a township line.

Boundary Calculation
Along Irregular Township Exteriors

BLM Manual: 5-36. *Some township boundaries, not established as straight lines, are termed "irregular" exteriors. Parts were surveyed from opposite directions and the intermediate portion was completed later by random and true line, leaving a fractional distance. Such irregularity follows some material departure from the basic rules for the establishment of original surveys. A modified form of single proportionate measurement is used in restoring lost corners on such boundaries. This is also applicable to a section line or a township line which has been shown to be irregular by a previous retracement. Figure 71. (see next page)*

1912 GLO Plat of T33N, R9E



Topographic Calls as Evidence

BLM Manual 5-16
Misapplication usually may be avoided by applying the following tests:

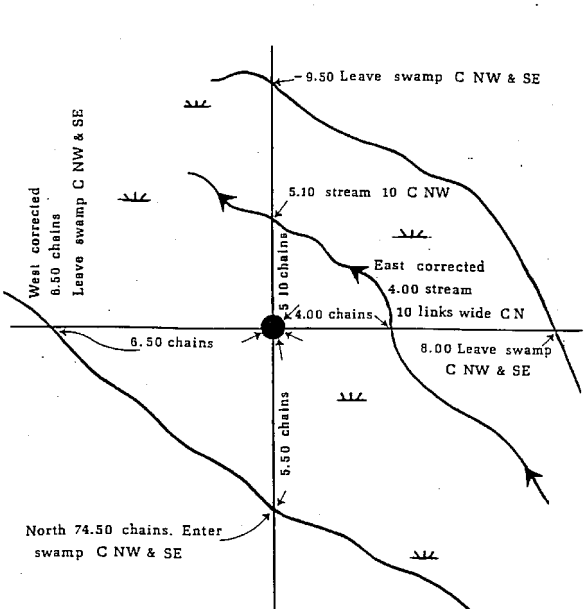
(1) The determination should result in a definite locus within a small area.

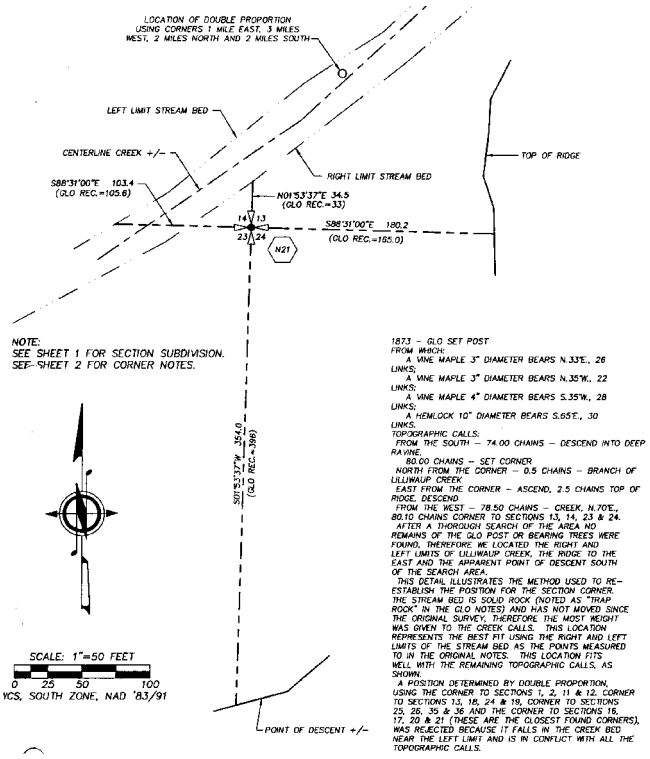
(2) The evidence should not be susceptible of more than one reasonable interpretation.

(3) The corner locus should not be contradicted by evidence of a higher class or by other topographic notes.

Is this a Corner which could be restored from Topographic Calls?

CORNER RESTORATION FROM NATURAL FEATURE CALLS



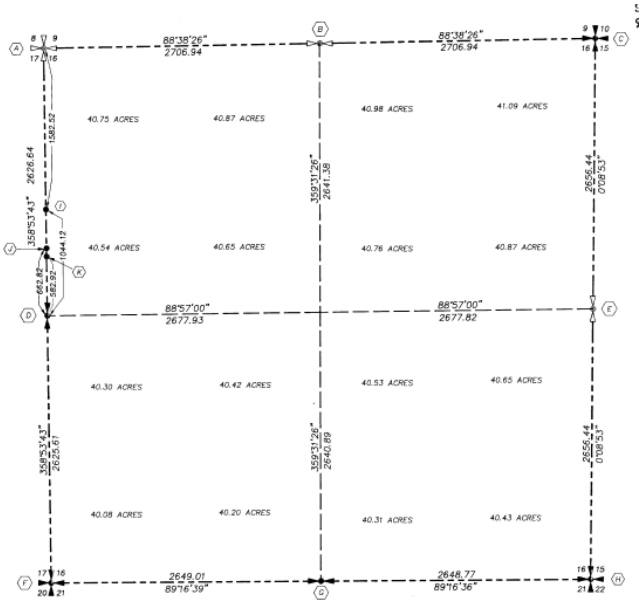


Narrative describing the corner restoration method

THIS DETAIL ILLUSTRATES THE METHOD USED TO RE-ESTABLISH THE POSITION FOR THE SECTION CORNER. THE STREAM BED IS SOLID ROCK (NOTED AS "TRAP ROCK" IN THE GLO NOTES) AND HAS NOT MOVED SINCE THE ORIGINAL SURVEY, THEREFORE THE MOST WEIGHT WAS GIVEN TO THE CREEK CALLS. THIS LOCATION REPRESENTS THE BEST FIT USING THE RIGHT AND LEFT LIMITS OF THE STREAM BED AS THE POINTS MEASURED TO IN THE ORIGINAL NOTES. THIS LOCATION FITS WELL WITH THE REMAINING TOPOGRAPHIC CALLS, AS SHOWN.

A POSITION DETERMINED BY DOUBLE PROPORTION, USING THE CORNER TO SECTIONS 1, 2, 11 & 12. CORNER TO SECTIONS 13, 18, 24 & 19, CORNER TO SECTIONS 25, 26, 35 & 36 AND THE CORNER TO SECTIONS 16, 17, 20 & 21 (THESE ARE THE CLOSEST FOUND CORNERS), WAS REJECTED BECAUSE IT FALLS IN THE CREEK BED NEAR THE LEFT LIMIT AND IS IN CONFLICT WITH ALL THE TOPOGRAPHIC CALLS.

Restoration Using Survey Records
Section 16, T17N, R28E



In this case the survey record was employed and the corner was restored using a simple one point control.

G.L.O. CORNER SYMBOLS:

FOUND OR ACCEPTED.

CALCULATED – SET.

CALCULATED – NOT SET.

131

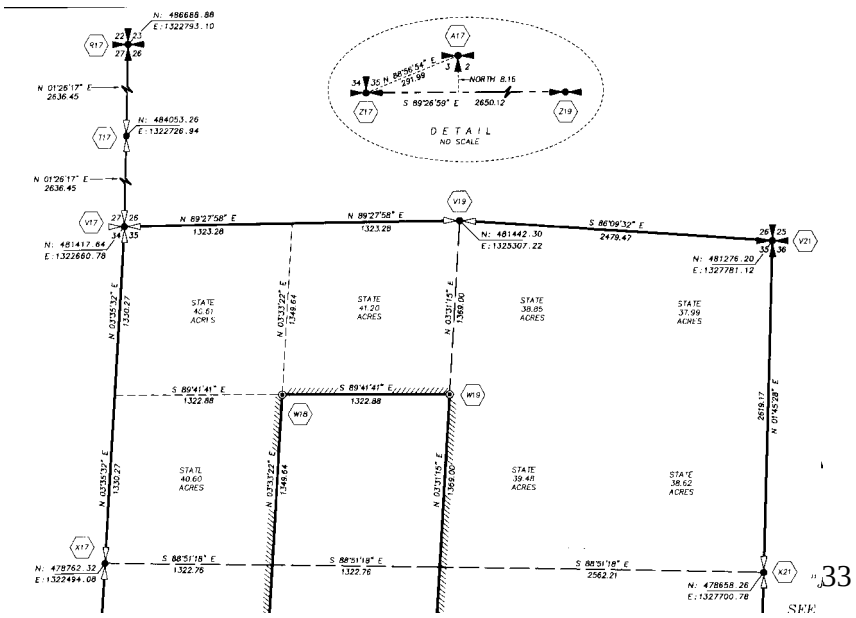
Using Survey Records
The Narrative

(A) NORTHWEST CORNER SECTION 16

CALCULATED CORNER
THIS CORNER POSITION FALLS WITHIN POTHOLES
RESERVOIR AND NOTHING WAS RECOVERED.
IN 1881 GLO SURVEYOR EDSON BRIGGS DEPOSITED
CHARCOAL, DUG PITS, RAISED AN EARTH MOUND
AND DROVE A STAKE INTO ONE OF THE PITS.
IN 1924 EUGENE LOGAN, CE FOR WASHINGTON WATER
POWER TIED A POINT AT THE CENTER OF A
ROAD INTERSECTION WITH A FENCELINE AS
NOTED ON A RIGHT OF WAY PLAT FILED WITH
D.N.R. UNDER APPLICATION #12330.
IN 1938 U.S.B.R. HELD A CORNER POSITION ON A
FENCE AND IN THE NORTHEAST CORNER OF A 4
WAY ROAD JUNCTION, ILLUSTRATED ON A
U.S.B.R. MAP.
THIS SURVEY CALCULATED THE CORNER POSITION BY
HOLDING ALIGNMENT OF THE SOUTH 1/2 MILE OF THE
WEST LINE OF SECTION 16 AND USING A GRID U.S.B.R.
DISTANCE FOR THE LENGTH OF THE NORTH 1/2 MILE OF
SAID WEST LINE. AN ALTERNATE POSITION WAS
EXAMINED BY HOLDING ALIGNMENT OF THE WEST 1/4
CORNER AND A FOUND MONUMENT 582.9 FEET NORTH OF
THE 1/4. THIS CREATED A POSITION 0.3 FEET EAST
OF THE ACCEPTED POSITION AND WAS NOT USED.

132

Another Example of Using Survey Records
Section 35, T33N, R5E



The Narrative

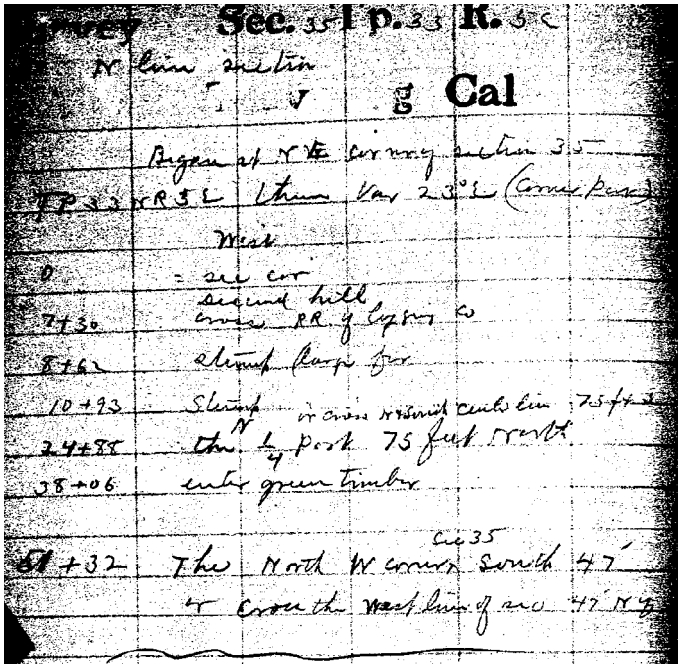
The Northwest corner and the North 1/4 corner of Section 35 were reestablished using measurements found in the 1911 field book of John Meehan, Skagit County Surveyor. That field book shows Mr. Meehan starting at the Northeast corner of Section 35 and running a line West 5,132 feet, calling out objects along the way. At 730 feet he crossed a railroad grade. At 862 feet he called a large Fir stump (now 115"). At 1,093 feet he called another stump (now 87"). At 2,488 feet he said the North 1/4 corner post was 75 feet North. At 5,132 feet he said the Northwest section corner post was 47 feet south. Our survey found and tied the old railroad grade and two large Fir stumps, all of which turned out to be where Meehan's notes show them. Mr. Meehan's work, particularly during this time period, has a reputation for being very reliable, therefore

Narrative continued

we decided to use his notes to reestablish the Northwest corner and North 1/4 corner. The method for doing so is as follows: We recovered the Northeast section corner and chose to use said section corner and the 87" Fir stump to establish the base-line run by Meehan. From that base-line, we located the positions for the North 1/4 corner and Northwest section corner using Meehan's stationing and offsets of 75 feet and 47 feet, measured perpendicular from the base-line.

The above solution was chosen in favor of a double proportion for two primary reasons: (1) the general reliability of Meehan's work and (2) based on analysis of GLO calls on the ground, the GLO surveyor appears to have stubbed his lines West, South and East.

John Meehan's Field Book



Method for restoring corners from Meehan's survey